The Electrochemical Society . . .

106th Meeting

BOSTON

October 3rd to 7th, 1954

LOCAL COMMITTEE

General and Advisory Committee

S. E. EATON, *General Chairman*
CHARLES LEVY, *Secretary-Treasurer*

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Plant Visits and Transportation

RICHARD R. RICHARDS

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Publicity

ALBERT O. MERRILL

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Speakers and Entertainment

H. H. UHLIG and L. B. ROGERS

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Ladies' Entertainment

MRS. H. H. UHLIG and MRS. L. B. ROGERS

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Membership

HORACE HOMER

■

Registration

ROBERT C. WADE

■

Arrangements

E. GORDON

THE ELECTROCHEMICAL SOCIETY

One Hundred and Sixth Meeting

Sunday through Thursday
October 3, 4, 5, 6, and 7, 1954

CONDENSED TECHNICAL PROGRAM

Battery--Theoretical Electrochemistry (Abs. 1-24)
(All sessions in Parlors B and C)
Monday, Oct. 4 -- 9:15 A.M.-12:00 M.
Monday, Oct. 4 -- 2:00 P.M.-5:00 P.M.
Tuesday, Oct. 5 -- 9:00 A.M.-12:00 M.
Tuesday, Oct. 5 -- 2:00 P.M.-4:45 P.M.

Battery (Abs. 24-36)
(All sessions in Bay State Room)
Wednesday, Oct. 6 -- 9:00 A.M.-12:00 M.
Wednesday, Oct. 6 -- 2:00 P.M.-4:15 P.M.

Corrosion (Abs. 37-74)
(All sessions in Ballroom Foyer)
Monday, Oct. 4 -- 2:00 P.M.-5:00 P.M.
Tuesday, Oct. 5 -- 9:00 A.M.-12:00 M.
Tuesday, Oct. 5 -- 2:00 P.M.-5:00 P.M.
Wednesday, Oct. 6 -- 9:00 A.M.-12:00 M.
Wednesday, Oct. 6 -- 2:00 P.M.-5:15 P.M.
Thursday, Oct. 7 -- 9:00 A.M.-12:00 M.
Thursday, Oct. 7 -- 2:00 P.M.-4:30 P.M.

Electrodeposition (Abs. 75-100)
(All sessions in Parlor A)
Monday, Oct. 4 -- 9:15 A.M.-11:45 A.M.
Monday, Oct. 4 -- 2:00 P.M.-4:45 P.M.
Tuesday, Oct. 5 -- 9:00 A.M.-12:00 M.
Tuesday, Oct. 5 -- 2:00 P.M.-4:30 P.M.

Electrothermics and Metallurgy (Abs. 101-121)
(All sessions in Parlor A)
Wednesday, Oct. 6 -- 9:15 A.M.-11:30 A.M.
Wednesday, Oct. 6 -- 2:00 P.M.-5:00 P.M.
Thursday, Oct. 7 -- 9:30 A.M.-12:00 M.
Thursday, Oct. 7 -- 2:00 P.M.-5:05 P.M.

GENERAL INFORMATION

Convention Headquarters will be at the Hotel Statler, Park Square, Boston, Mass.

Rates per day for rooms will be: single room with bath: $6.00, 6.50, 7.50, 8.00, 8.50, 9.50, 10.00, 11.00; double-bed room with bath: $10.50, 11.00, 11.50, 12.50, 13.00, 14.00; twin-bed room with bath: $12.00, 13.00, 13.50, 14.00, 14.50, 15.00, 16.00, 16.50; for additional person in double or twin-bed room the extra charge is $3.00 per day; suites: Living room, bedroom, and bath for one or two persons: $27.00, 27.50, 28.50, 32. If a room at the rate requested is unavailable, one at the nearest available rate will be reserved.

Requests for room reservations should be mailed to Mr. Foster Whitehouse, Hotel Statler, Park Square at Arlington Street, Boston 17, Mass., with mention of The Electrochemical Society.

The Secretary will have his office in the Society's Headquarters rooms, Parlors D and E.

Technical sessions will be held in rooms on the mezzanine floor, with the exception of those held in the Bay State Room on the first floor.

REGISTRATION

The registration desk will be located on the mezzanine floor. On Sunday, October 3, the registration desk will be open between 5:00 P.M. and 8:00 P.M. On Monday, Tuesday, Wednesday and Thursday, October 4 to 7, the registration desk will be open from 8:00 A.M. to 5:00 P.M. Registration fees are:

Members.....$7.00	Students.....$1.00
Ladies.....$3.00	Nonmembers.....$10.00

INFORMATION ABOUT BOSTON

Boston--capital of Massachusetts, birthplace of American liberty, hub of the universe--is America's oldest large city. Boston's historic landmarks of the prerevolutionary era give a glimpse into the yesterday of American history, while its universities and research centers open wide vistas to tomorrow. It is this inevitable union between past and future that makes Boston unique.

The historic points of interest charm every newcomer to Boston.

The Park Street Church, at the busy corner of Park and Tremont Streets, is the site of Boston's first jail, and the place where "America" was first sung publicly. On the nearby corner of Tremont and School Streets stands King's Chapel, one of the oldest churches in America. British Tories worshipped here during the siege of Boston, 1775-76. One headstone in the adjacent burial ground bears the date February 18, 1630. The Old South Meeting House, where early Bostonians gathered to plan the "Boston Tea Party", is located on Washington Street. Further down on the same street is the Old State House, oldest state building in the U. S., built in 1657. It contains a collection of early Americana, and is historically known as the site where the convention met to adopt the Federal Constitution. At the rear of the State House, marked by unique paving, is the site of the Boston Massacre, where the first blood of the Revolution was shed, March 4, 1770.

On North Square is the Paul Revere House, oldest frame structure in Boston, built in 1676, and purchased by Revere nearly a century later. Around the corner on Salem Street is the Old North Church, oldest church edifice in Boston. Here hung the lanterns ("two if by sea") that told Paul Revere the British were coming.

Across the Charlestown Bridge is the Boston Navy Yard, now closed to visitors. Covering approximately 123 1/2 acres, it has nearly 1 1/2 miles of waterfront, three dry docks, a marine railway, 10 ship piers, and about 150 buildings. The famous U. S. Frigate "Constitution", launched in 1777, is docked here. Affectionately known as "Old Ironsides", this ship was in some 40 engagements without suffering defeat. Rebuilt by funds from American school children, it is open to the public.

Boston's outstanding museums, universities, and theaters are responsible for the city's being called the cultural center of America.

The Museum of Fine Arts on Huntington Avenue at the Fenway, is unsurpassed for its Asiatic art collection. It also boasts fine collections of royal Egyptian sculpture, Greek sculpture, textiles and prints, and fine paintings with examples of all periods. Regularly guided tours are available.

On the south end of the Fenway is the Isabella Stewart Gardner Museum, famous for its lovely Venetian court and gardens. It is filled with rare treasures from all over the world, including fine tapestries and European paintings. Classical concerts are held here three days a week.

The Museum of Science, at Science Park at the end of the Charles River Esplanade, for the first time combines exhibits of natural history, science and industry, man and public health, and a planetarium. Museum curiosities include the world's first model of a uranium-235 atom; the 9,000,000 candle-power lens from the lighthouse at Navesink Highlands, N. J.; a two-foot housefly; and man-made lightning.

Boston is a traditional "tryout" town for Broadway plays, with five legitimate theaters. The renowned Boston Symphony has fall and winter concerts.

As a shopping center, Boston is second only to New York. Many of the large department stores are conveniently grouped in the downtown Washington and Tremont Street area. No Boston shopper, however, should miss the exclusive and unique specialty shops located on Boylston and Newbury Streets.

Whether it be broiled scrod or lobster thermidor, little necks on the half-shell or fried shrimp, Boston seafood offers an experience to any visitor. The cold, flavor-heightened waters of the North Atlantic provide the best seafoods obtainable, and experienced Boston cooks prepare these using the time-tested recipes of their Yankee ancestors.

SPECIAL SYMPOSIA

The Battery and Theoretical Electrochemistry Divisions are holding special symposia on Basic Electrode Processes, Cathode Processes, and Cell Processes, on Monday and Tuesday, October 4 and 5, in Parlors B and C (mezzanine). The Corrosion Division has planned a symposium on Stress Corrosion Phenomena for Monday afternoon, October 4, and Tuesday, October 5, in the Ballroom Foyer (mezzanine).

The Electrothermics and Metallurgy Division has scheduled a round-table discussion on Safety in Handling Zirconium Powder for Wednesday, October 6, at 9:15 A.M.-11:30 A.M. in Parlor A (Mezzanine).

ACHESON MEDAL LECTURE

Mr. George Heise, who retired in 1953 from the National Carbon and Carbide Laboratories in Cleveland, is the 1954 recipient of the Acheson Medal. He will deliver the Acheson Medal Lecture at the banquet on Tuesday, October 5, at 7:30 P.M. in the Ballroom (Mezzanine).

LUNCHEONS AND DINNERS

Society Luncheon

The general Society Luncheon will be held on Monday, October 4, at 12:30 P.M. in the Georgian Room (Mezzanine). Professor Donald H. Menzel, Harvard College Observatory, Cambridge, Mass., will speak on flying saucers.

Acheson Medal Banquet

A reception for the Acheson Medalist, Mr. George Heise, will be held on Tuesday, October 5, at 6:30 P.M. in the Ballroom Foyer. Following the reception, a banquet will be held at 7:30 P.M. in the Ballroom. Mr. Heise will deliver the Acheson Medal Lecture.

Society Cocktail Party and Banquet

A cocktail party (C.O.D.) will be held on Wednesday, October 6, at 6:30 P.M. in the Ballroom Foyer (Mezzanine), followed by a banquet at 7:30 P.M. in the Ballroom. Dr. Harold E. Edgerton, of M.I.T., will give a general illustrated talk on ultra high speed and underwater photography.

PLANT TRIPS

The following plant trips have been arranged to supplement the technical program.

Monday afternoon -- Ionics, Inc., and Arthur D. Little, Inc. At the Ionics plant there will be a demonstration of an electric membrane demineralizer developed for the treatment of naturally occurring saline waters and other mineral containing solutions by the use of electricity in conjunction with novel selectively conductive membranes. At Arthur D. Little there will be a tour of this consulting company's new Acorn Park research and development laboratory, which is outstanding as an example of low cost but high utility laboratory

construction. This will be followed by refreshments and discussion of an operations research study of a corrosion problem in the chemical industry.

Tuesday morning -- Watertown Arsenal. An inspection of the large plating shop and plating laboratory will be followed by a presentation of the work the Arsenal is doing in high vacuum metallurgy using the vacuum fusion apparatus and the mass spectrometer. (Only U. S. citizens are permitted to visit the Arsenal.)

Wednesday afternoon -- Massachusetts Institute of Technology. The visit will be to the Corrosion Laboratory, which is administered by Society Vice-President, Dr. H. H. Uhlig, and to the Computer Laboratory where the "Whirlwind" digital computer will be featured.

LADIES' PROGRAM

Ladies' Headquarters will be in the Hancock Room (Mezzanine) throughout the meeting.

Monday morning -- A get-acquainted meeting will be held at which coffee (or tea!) and rolls will be served in the Hancock Room (Mezzanine). Plans for later activities will be discussed (complimentary).

Monday Luncheon -- The ladies are invited to attend the Society Luncheon in the Georgian Room (Mezzanine) ($3.50).

Monday afternoon -- Sightseeing trip to Lexington and Concord to visit historic spots including Wayside Inn, Orchard House Antiquarian Society, Emerson's House, and The Old Manse (transportation complimentary).

Tuesday -- All-day trip to the North Shore - Rockport, Gloucester, Swampscott, Marblehead, and Salem. Luncheon at the Haller-Daniels House in Salem. Number limited to 40 ($2.00).

Tuesday evening -- Cocktails and dinner (in the Ballroom) (Mezzanine) in honor of the Acheson Medalist is a must for everyone ($9.00 per couple).

Wednesday morning -- Coffee will be served in the Hancock Room (Mezzanine) before starting for the First Iron Works Restoration in Saugus. There has been no slip-up! This is a place the ladies will enjoy. Luncheon will be served at the Towne

Lynne House in Lynnfield (transportation complimentary).

Wednesday afternoon -- From the M. I. T. Faculty Club, located on the banks of the Charles River in Cambridge, one can see, in a sweeping glance, the Boston skyline from Beacon Hill to the towers of Boston University. Tea will be served (complimentary).

Wednesday evening -- The ladies will enjoy the Society Banquet and entertainment that has been arranged in the Ballroom (Mezzanine) ($5.50).

Thursday morning -- Coffee will again be served in the Hancock Room (Mezzanine). At that time, the hostesses will arrange for small groups to visit points of interest, including Fine Arts Museum, Isabella Gardner Museum, Chestnut Hill Shopping Center, and historic points in Cambridge and Boston.

LUNCHEONS AND BUSINESS MEETINGS OF DIVISIONS

Battery Division will hold a luncheon and business meeting on Tuesday, October 5, at 12:30 P.M. in the Bay State Room (1st floor).

Corrosion Division will hold a luncheon and business meeting on Wednesday, October 6, at 12:30 P.M. in the Ballroom (Mezzanine).

Electrodeposition Division will hold a luncheon and business meeting on Tuesday, October 5, at 12:30 P.M. in Parlor A (Mezzanine).

BOARD AND COMMITTEE MEETINGS

Sunday, October 3, 10:00 A.M. -- Meeting of the Ways and Means Committee in Parlors D and E (Mezzanine).

Sunday, October 3, 2:30 P.M. -- Meeting of the Board of Directors in Parlors D and E (Mezzanine).

Monday, October 4, 5:00 P.M. -- Meeting of the Editorial Staff in Parlor E (Mezzanine).

Monday, October 4, 5:00 P.M. -- Meeting of the Local Section Advisory Committee in Parlor D (Mezzanine). This meeting represents the transition from the Local Section Advisory Committee to the

Council of Local Sections.

Tuesday, October 5, 5:00 P.M. -- Meeting of the Membership Committee in Parlor D (Mezzanine).

Wednesday, October 6, 5:00 P.M. -- Meeting of the Sustaining Membership Committee in Parlor D (Mezzanine).

COST OF VARIOUS FUNCTIONS
(other than registration)

Society Luncheon	$3.50
Division Luncheons	$3.50
Acheson Medal Reception and Banquet	
(single)	$5.50
(couple)	$9.00
Society Banquet	$5.50
(cocktails)	$0.25 each
Plant Trips	$1.00

JOURNALS

Copies of the June, July, August, and September issues of the Journal of The Electrochemical Society will be available at the registration desk. The price of single copies of the Journal is $1.25 to members and $1.50 to nonmembers.

DISCUSSION

There will be no recordings made of oral discussions. Those contributing to the discussion of a paper and desiring their remarks published will be supplied with a printed form on which any discussion may be written. These forms should be given to the Secretary-Treasurer of the Division at the end of the session. The discussion will then be referred to the authors for reply. Written discussion will be accepted up to two months following publication of any article in the Journal.

A discussion section is published semiannually in the Journal.

EXTENDED ABSTRACTS

The Battery Division is making available an extended abstract booklet containing 1000-word abstracts of most of the papers presented at the Boston Meeting symposia. Copies of the booklet will be on sale at the registration desk.

TECHNICAL PROGRAM

Monday, October 4, 1954

9:00 A.M.--Formal Opening of the 106th Convention, with Introduction by General Chairman S. E. Eaton and response by President Marvin J. Udy (Parlors B and C, Mezzanine).

BATTERY--THEORETICAL ELECTROCHEMISTRY

Joint Symposium

Monday, October 4, 1954

Basic Electrode Processes

with George W. Heise presiding

(Parlors B and C, Mezzanine)

9:15 A.M.--"Electrode Kinetics in Relation to Battery Processes" by Ernest Yeager, Dept. of Chemistry, Western Reserve University, Cleveland, Ohio. (Abstract No. 1)

9:45 A.M.--"Thermodynamics of Electrochemical Cells" by Walter J. Hamer, National Bureau of Standards, Washington, D. C. (Abstract No. 2)

10:15 A.M.--"Mass Transfer in Electrode Reactions" by Carl Wagner, Dept. of Metallurgy, Massachusetts Institute of Technology, Cambridge, Mass. (Abstract No. 3)

11:00 A.M.--"Rate of Reaction between a Porous Solid and a Fluid Component with Diffusion Controlling" by Howard J. Strauss, Electric Storage Battery Co., Philadelphia, Pa. (Abstract No. 4)

11:30 A.M.--"Behavior of Interstitial Solutes in the Transition Metals" by R. S. Dean and W. W. Gullett, Chicago Development Corp., Riverdale, Md. (Abstract No. 5)

12:30 P.M.--Society Luncheon in the Georgian Room (Mezzanine).

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BATTERY--THEORETICAL ELECTROCHEMISTRY
Joint Symposium (cont'd)
Cathode Processes
with Oliver W. Storey presiding
(Parlors B and C, Mezzanine)

2:00 P.M.--"Cathode Processes in Electrochemical Cells" by E. Willihnganz, Gould-National Batteries, Inc., Depew, N. Y. (Abstract No. 6)

2:30 P.M.--"The Electrochemistry of Manganese Dioxide" by W. C. Vosburgh, Dept. of Chemistry, Duke University, Durham, N. C. (Abstract No. 7)

3:00 P.M.--"A Further Study of Electrodeposited Manganese Dioxide Electrodes" by W. C. Vosburgh, Richard S. Johnson, John S. Reiser, and Douglas R. Allenson, Dept. of Chemistry, Duke University, Durham, N. C. (Abstract No. 8)

3:30 P.M.--"Formation of Manganese(II) Ion in the Discharge of the Manganese Dioxide Electrode" by A. M. Chreitzberg, Jr., Douglas R. Allenson, and W. C. Vosburgh, Dept. of Chemistry, Duke University, Durham, N. C. (Abstract No. 9)

4:00 P.M.--"The Overpotential of the Manganese Dioxide Electrode" by A. M. Chreitzberg, Jr., and W. C. Vosburgh, Dept. of Chemistry, Duke University, Durham, N. C. (Abstract No. 10)

4:30 P.M.--"Cathode Reactions of the Leclanché Dry Cell" by N. C. Cahoon, R. S. Johnson, and M. P. Korver, National Carbon Research Labs., Cleveland, Ohio. (Abstract No. 11)

BATTERY--THEORETICAL ELECTROCHEMISTRY
Joint Symposium (cont'd)
Tuesday, October 5, 1954
Cell Processes
with C. C. Rose presiding
(Parlors B and C, Mezzanine)

9:00 A.M.--"Lead Dioxide Reactions in the Storage Battery" by E. Willihnganz, Gould-National Batteries, Inc., Depew, N. Y. (Abstract No. 12)

9:25 A.M.--"Influence of Metallic Additions upon Lead-Acid Storage Battery Performance" by Bernard Agruss, Research Labs., National Lead Co., Brooklyn, N. Y. (Abstract No. 13)

9:50 A.M.--"Lead Storage Battery Performance in Car Service" by Dudley Haskell, W. P. Fuller & Co., South San Francisco, Calif. (Abstract No. 14)

10:15 A.M.--"Lead-Acid Storage Batteries--Barium Sulfate as a Positive Plate Contaminant" by J. F. Dittmann and H. R. Harner, Eagle-Picher Co., Joplin, Mo. (Abstract No. 15)

10:40 A.M.--"Determination of the Internal Resistance of Lead-Acid Storage Cells" by J. J. Lander and E. E. Nelson, Naval Research Lab., Washington, D. C. (Abstract No. 16)

11:05 A.M.--"Resistance and Polarization in the Storage Battery by A-C Bridge Methods" by E. Willihnganz, Gould-National Batteries, Inc., Depew, N. Y. (Abstract No. 17)

11:30 A.M.--"The Internal Resistance of Primary and Secondary Batteries and Its Determination" by C. R. G. Drotschmann, Wetenschappelijk en Technisch Research en derzelver Exploitatie, Utrecht, Holland. (Abstract No. 18)

12:30 P.M.--Battery Division Luncheon and Business Meeting in the Bay State Room (1st floor).

BATTERY--THEORETICAL ELECTROCHEMISTRY
Joint Symposium (cont'd)
Cell Processes (cont'd)
with Ernest Yeager presiding
(Parlors B and C, Mezzanine)

2:00 P.M.--"Resistance Studies on Various Types of Dry Cells" by Richard Glicksman and C. K. Morehouse, RCA Research Labs., Princeton, N. J. (Abstract No. 19)

2:25 P.M.--"Reactions at Metallic Anodes in Primary and Secondary Cells: A Review" by N. C. Cahoon, National Carbon Research Labs., Cleveland, Ohio. (Abstract No. 20)

2:55 P.M.--"Reactions in the Air Depolarized Cell: A Review" by E. A. Schumacher, National Carbon Research Labs., Cleveland, Ohio. (Abstract No. 21)

3:25 P.M.--"Anodic Corrosion of Zinc in Alkali" by T. P. Dirkse, Calvin College, Grand Rapids, Mich. (Abstract No. 22)

3:50 P.M.--"Theoretical Standard Electromotive Forces for Cells Containing a Single Solid or Molten Halide Electrolyte" by Walter J. Hamer, Marjorie S. Malmberg, and Bernard Rubin, National Bureau of Standards, Washington, D. C. (Abstract No. 23)

4:15 P.M.--"Nuclear Batteries" by William Shorr, Signal Corps Engineering Labs., Ft. Monmouth, N. J. (Abstract No. 24)

BATTERY

Wednesday, October 6, 1954

Technology of Batteries
with E. Willihnganz presiding
(Bay State Room, 1st floor)

9:00 A.M.--"A Method of Plastic Impregnation for the Investigation of Storage Battery Failure" by A. C. Simon and E. L. Jones, Naval Research Lab., Washington, D. C. (Abstract No. 25)

9:25 A.M.--"Further Studies on the Anodic Corrosion of Lead in Sulfuric Acid Solutions" by J. J. Lander, Naval Research Lab., Washington, D. C. (Abstract No. 26)

9:50 A.M.--"Anodization of Lead in Sulfuric Acid" by Jeanne Burbank, Naval Research Lab., Washington, D. C. (Abstract No. 27)

10:15 A.M.--"Rapid Corrodibility Evaluation of Lead-Acid Storage Cell Positive Grid Alloys" by James F. McGivern, Jr., Metallurgical Research Lab., Electric Storage Battery Co., Philadelphia, Pa. (Abstract No. 28)

10:40 A.M.--"A Rapid Test for Sulfation" by C. C. Rose, Willard Storage Battery Co., Cleveland, Ohio. (Abstract No. 29)

11:05 A.M.--"Role of Inverse Segregation and Redistribution of Solute Atoms in the Freezing of Hypoeutectic Lead-Antimony Alloys" by A. C. Simon and E. L. Jones, Naval Research Lab., Washington, D. C. (Abstract No. 30)

11:30 A.M.--"Color Changes in Lead Oxides with Changes in Temperature" by Everett J. Ritchie and Paul E. Jensen, Eagle-Picher Research Labs., Joplin, Mo. (Abstract No. 31)

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BATTERY

Technology of Batteries (cont'd)
with Everett J. Ritchie presiding
(Bay State Room, 1st floor)

2:00 P.M.--"Sealed Nickel-Cadmium Cells" by Ernst G. Baars, Signal Corps Engineering Labs., Ft. Monmouth, N. J. (Abstract No. 32)

2:25 P.M.--"Gassing of Dry Cells" by Earl Otto and Woodward G. Eicke, Jr., National Bureau of Standards, Washington, D. C. (Abstract No. 33)

2:50 P.M.--"Effect of Low Temperature Storage upon the Shelf-Life Characteristics of Dry Batteries" by Charles H. Clark, Signal Corps Engineering Labs., Ft. Monmouth, N. J. (Abstract No. 34)

3:15 P.M.--"A Film Lining for High Capacity Dry Cells" by N. C. Cahoon and M. P. Korver, National Carbon Research Labs., Cleveland, Ohio. (Abstract No. 35)

3:40 P.M.--"Effect of High Temperature Storage on the Stability of Battery-Grade Manganese Dioxide" by Arthur F. Daniel, Signal Corps Engineering Labs., Ft. Monmouth, N. J. (Abstract No. 36)

CORROSION

Monday, October 4, 1954

Symposium on Stress Corrosion Phenomena
with W. D. Robertson presiding
(Ballroom Foyer, Mezzanine)

2:00 P.M.--"Introductory Review of the Problem" by J. J. Harwood, Office of Naval Research, Washington, D. C. (Abstract No. 37)

2:45 P.M.--"Fracture Mechanics" by E. Orowan, Massachusetts Institute of Technology, Cambridge, Mass. (Abstract No. 38)

3:30 P.M.--"Crystallography and Corrosion Cracking" by W. D. Robertson, Dept. of Metallurgy, Hammond Metallurgical Lab., Yale University, New Haven, Conn. (Abstract No. 39)

4:15 P.M.--"Stress Corrosion of Homogeneous Alloys" by L. Graf, Max-Planck Institute fur Metallforschung, Stuttgart, Germany. (Abstract No. 40)

CORROSION

Tuesday, October 5, 1954

Symposium on Stress Corrosion Phenomena (cont'd)
with Raymond B. Hoxeng presiding
(Ballroom Foyer, Mezzanine)

9:00 A.M.—"Grain Boundary Structure" by Bruce Chalmers, Harvard University, Cambridge, Mass. (Abstract No. 41)

9:45 A.M.—"Metallurgical Aspects of Stress Corrosion in Aluminum Alloys" by E. C. W. Perryman, Aluminium Laboratories, Ltd., Kingston, Ont., Canada. (Abstract No. 42)

10:30 A.M.—"Role of Surface Adsorption of Solute Atoms in Stress Corrosion of Alloys" by Rudolph Speiser and J. W. Spretnak, Dept. of Metallurgy, Ohio State University, Columbus, Ohio. (Abstract No. 43)

11:15 A.M.—"Stress Corrosion of Austenitic Stainless Steel" by C. Edeleanu, Brown-Firth Research Labs., Sheffield, England. (Abstract No. 44)

CORROSION

Symposium on Stress Corrosion Phenomena (cont'd)
with T. P. May presiding
(Ballroom Foyer, Mezzanine)

2:00 P.M.—"Occlusion of Hydrogen in Iron and Its Alloys" by W. R. Heller, Shell Development Co., Emeryville, Calif. (Abstract No. 45)

2:45 P.M.—"Hydrogen Embrittlement" by W. M. Baldwin, Case Institute of Technology, Cleveland, Ohio. (Abstract No. 46)

3:30 P.M.—"Caustic and Nitrate Cracking of Steel" by R. N. Parkins, University of Durham, Newcastle upon Tyne, England. (Abstract No. 47)

4:15 P.M.—"Laboratory Investigation Techniques Relating to Stress Corrosion Cracking" by H. R. Copson, Research Lab., International Nickel Co., Inc., Bayonne, N. J. (Abstract No. 48)

CORROSION (cont'd)

Wednesday, October 6, 1954

with J. V. Petrocelli presiding
(Ballroom Foyer, Mezzanine)

9:00 A.M.--"An Interpretation of the Significance of the Potentials of Passive Iron" by M. J. Pryor, Dept. of Metallurgical Research, Kaiser Aluminum & Chemical Corp., Spokane, Wash. (Abstract No. 49)

9:30 A.M.--"Electrochemical Behavior of Iron in Oxygen Free Acid Environments" by Milton Stern and Herbert H. Uhlig, Corrosion Lab., Dept. of Metallurgy, Massachusetts Institute of Technology, Cambridge, Mass. (Abstract No. 50)

10:00 A.M.--"Nature of Film on Iron Passivated by Nitric Acid" by Herbert H. Uhlig and Thomas L. O'Connor, Corrosion Lab., Dept. of Metallurgy, Massachusetts Institute of Technology, Cambridge, Mass. (Abstract No. 51)

10:30 A.M.--"Corrosion Inhibitors and Polarographic Maxima" by Harry C. Gatos, Engineering Research Lab., Engineering Dept., E. I. du Pont de Nemours & Co., Inc., Wilmington, Del. (Abstract No. 52)

11:00 A.M.--"A Theoretical Basis for a New Method of Investigating Corrosion Inhibition" by J. G. Jewell, Gulf Research & Development Co., Pittsburgh, Pa. (Abstract No. 53)

11:30 A.M.--"Effect of Oxygen, Chlorides, and Calcium Ion on Corrosion Inhibition of Iron by Polyphosphates" by Herbert H. Uhlig, D. N. Triadis, and Milton Stern, Corrosion Lab., Dept. of Metallurgy, Massachusetts Institute of Technology, Cambridge, Mass. (Abstract No. 54)

12:30 P.M.--Corrosion Division Luncheon and Business Meeting in the Ballroom (Mezzanine).

CORROSION (cont'd)
with Harry C. Gatos presiding
(Ballroom Foyer, Mezzanine)

2:00 P.M.--"Contribution to the Theory of Electropolishing" by Carl Wagner, Dept. of Metallurgy, Massachusetts Institute of Technology, Cambridge, Mass. (Abstract No. 55)

2:30 P.M.--"The Mechanism of Metallographic Etching, I. Reaction Potentials of a Two-Phase Brass in Various Etching Reagents" by George L. Kehl and Max Metlay, School of Mines, Columbia University, New York, N. Y. (Abstract No. 56)

3:00 P.M.--"The Mechanism of Metallographic Etching, II. Current-Potential Relationships during Etching of a Two-Phase Brass in Various Reagents" by Max Metlay and George L. Kehl, School of Mines, Columbia University, New York, N. Y. (Abstract No. 57)

3:30 P.M.--"Crystallographic Dependence of the Oxidation Potential of Copper" by W. E. Tragert and William D. Robertson, Dept. of Metallurgy, Hammond Metallurgical Lab., Yale University, New Haven, Conn. (Abstract No. 58)

4:00 P.M.--"The Formation of Anodic Oxide Films on Cathodes" by D. A. Vermilyea, Research Lab., General Electric Co., Schenectady, N. Y. (Abstract No. 59)

4:30 P.M.--"Fundamental Thermodynamics and Kinetics of Electrode Processes" by Pierre Van Rysselberghe, Dept. of Chemistry, University of Oregon, Eugene, Oreg. (Abstract No. 60)

4:45 P.M.--"Corrosion Inhibition and Cathodic Protection Examined from the Point of View of the Thermodynamics of Irreversible Processes" by Pierre Van Rysselberghe, Dept. of Chemistry, University of Oregon, Eugene, Oreg. (Abstract No. 61)

5:00 P.M.--"Codeposition Examined from the Point of View of the Thermodynamics of Irreversible Processes" by Pierre Van Rysselberghe, Dept. of Chemistry, University of Oregon, Eugene, Oreg. (Abstract No. 62)

CORROSION (cont'd)

Thursday, October 7, 1954

with C. V. King presiding

(Ballroom Foyer, Mezzanine)

9:00 A.M.--"The Isolation of Surface Films from Aluminum and Its Alloys" by M. J. Pryor and D. S. Keir, Dept. of Metallurgical Research, Kaiser Aluminum & Chemical Corp., Spokane, Wash. (Abstract No. 63)

9:25 A.M.--"The Anodic Treatment of Aluminum in Sulfuric Acid Solutions" by Roy C. Spooner, Aluminium Laboratories, Ltd., Kingston, Ont., Canada. (Abstract No. 64)

9:50 A.M.--"Depolarized Dissolution of Iron in

Acid Solution, I. Potential-Current Density Relationships" by A. C. Makrides, N. M. Komodromos, and Norman Hackerman, Dept. of Chemistry, University of Texas, Austin, Texas. (Abstract No. 65)

10:15 A.M.--"Stainless Steel in Ferric Chloride Solution. Exploratory Experiments" by Herman A. Liebhafsky and Arthur E. Newkirk, Research Lab., General Electric Co., Schenectady, N. Y. (Abstract No. 66)

10:40 A.M.--"Kinetics of the Corrosion of Copper in Acid Solutions" by John R. Weeks and George R. Hill, Institute for the Study of Rate Processes, University of Utah, Salt Lake City, Utah. (Abstract No. 67)

11:05 A.M.--"The Difference Effect on Aluminum Dissolving in Hydrofluoric and Hydrochloric Acids" by M. E. Straumanis and Y. N. Wang, Dept. of Metallurgy, School of Mines and Metallurgy, University of Missouri, Rolla, Mo. (Abstract No. 68)

11:30 A.M.--"The Corrosion of Aluminum in Potassium Chloride Solutions" by W. Beck, F. G. Keihn, and R. G. Gold, Lehigh University, Bethlehem, Pa. (Abstract No. 69)

CORROSION (cont'd)
with W. D. Robertson presiding
(Ballroom Foyer, Mezzanine)

2:00 P.M.--"The Oxidation of Iron-Molybdenum Alloys" by S. S. Brenner, Research Lab., General Electric Co., Schenectady, N. Y. (Abstract No. 70)

2:30 P.M.--"The Oxidation of Nickel-Molybdenum Alloys" by S. S. Brenner, Research Lab., General Electric Co., Schenectady, N. Y. (Abstract No. 71)

3:00 P.M.--"The Catastrophic Oxidation of Some Molybdenum Containing Alloys" by S. S. Brenner, Research Lab., General Electric Co., Schenectady, N. Y. (Abstract No. 72)

3:30 P.M.--"Kinetics of the Reaction of Hydrogen with Zirconium" by Jack Belle, B. B. Cleland, and M. W. Mallett, Battelle Memorial Institute, Columbus, Ohio. (Abstract No. 73)

4:00 P.M.--"Kinetics of the High Temperature Oxidation of Zirconium" by Jack Belle and M. W. Mallett, Battelle Memorial Institute, Columbus, Ohio. (Abstract No. 74)

ELECTRODEPOSITION

Monday, October 4, 1954

with C. A. Snavely presiding

(Parlor A, Mezzanine)

9:15 A.M.--"Brightening Agents for the Tin-II Sulfate-Sulfuric Acid Electrolyte" by C. A. Discher and F. C. Mathers, Indiana University, Bloomington, Ind. (Abstract No. 75)

9:40 A.M.--"Electrodeposition of Lead from Lead Phenol Sulfonate Solutions" by F. C. Mathers and Harry C. Gatos, Indiana University, Bloomington, Ind. (Abstract No. 76)

10:05 A.M.--"Electrodeposition of Rhodium" by Edward A. Parker, Technic Inc., Providence, R.I. (Abstract No. 77)

10:30 A.M.--"Electroless Nickel Plating of Internal Aluminum Surfaces" by P. H. Eisenberg and H. I. Raiklen, Atomic Energy Div., Sylvania Electric Products Inc., Bayside, N. Y. (Abstract No. 78)

10:55 A.M.--"Zincaloy -- A New Solderable Zinc Alloy Plating Process" by E. B. Saubestre, Physics Labs., Sylvania Electric Products Inc., Bayside, N. Y. (Abstract No. 79)

11:20 A.M.--"Use of a Fractional Factorial Experiment to Study a Manganese-Tin Alloy Plating Bath" by W. C. Schickner and A. B. Tripler, Jr., Battelle Memorial Institute, Columbus, Ohio. (Abstract No. 80)

12:30 P.M.--Society Luncheon in the Georgian Room (Mezzanine).

ELECTRODEPOSITION (cont'd)

with C. A. Snavely presiding

(Parlor A, Mezzanine)

2:00 P.M.--"Electrodeposition of Nickel at a Mercury Cathode" by J. T. Funkhouser and L. B. Rogers, Dept. of Chemistry and Lab. of Nuclear Science, Massachusetts Institute of Technology, Cambridge, Mass. (Abstract No. 81)

2:25 P.M.--"Separations with a Mercury Electrode. Determination of Certain Metallic Impurities in Vanadium Salts" by William E. Schmidt and Clark E. Bricker, Princeton University, Princeton, N. J. (Abstract No. 82)

2:50 P.M.--"Effect of Temperature Changes on the Polarographic Waves of Thallous, Cadmium, and Cobaltous Ions" by J. F. Murphy, Dept. of Metallurgical Research, Kaiser Aluminum & Chemical Corp., Spokane, Wash. (Abstract No. 83)

3:25 P.M.--"Permeation of Gases through Electrolytic Nickel Deposits, I. Determination of the Intrinsic Permeability of Nickel Deposits to Gases" by D. T. Ewing and J. Martin Tobin, Michigan State College, East Lansing, Mich., and D. Gardiner Foulke, Hanson-Van Winkle-Munning Co., Matawan, N. J. (Abstract No. 84)

3:50 P.M.--"Permeation of Gases through Electrolytic Nickel Deposits, II. Determination of the Effect of Several Variables upon the Intrinsic Permeability of Nickel Deposits to Gases" by D. T. Ewing and J. Martin Tobin, Michigan State College, East Lansing, Mich., and D. Gardiner Foulke, Hanson-Van Winkle Munning Co., Matawan, N. J. (Abstract No. 85)

4:15 P.M.--"Production of High-Purity Cobalt" by K. K. Kershner, F. W. Hoertel, and J. C. Stahl, Bureau of Mines, U. S. Dept. of the Interior, Rolla, Mo. (Abstract No. 86)

ELECTRODEPOSITION (cont'd)

Tuesday, October 5, 1954

Theory of Electrodeposition

with M. L. Holt presiding

(Parlor A, Mezzanine)

9:00 A.M.--"Catalysis of Electron Transfer Reactions" by J. F. Murphy, Dept. of Metallurgical Research, Kaiser Aluminum & Chemical Corp., Spokane, Wash. (Abstract No. 87)

9:25 A.M.--"A Theory of Chromium Plating from Chromic Acid Solution Based on Dynamic Cell Measurements" by Arthur A. Burr, Dept. of Metallurgical Engineering, Rensselaer Polytechnic Institute, Troy, N. Y. (Abstract No. 88)

9:50 A.M.--"Mass Spectrometric Examination of Hydrogen in Chromium Plated Steel" by Charles

Levy and George A. Consolazio, Watertown Arsenal Lab., Watertown, Mass. (Abstract No. 89)

10:15 A.M.--"Influence of the Transference Number in Plating from Anionic Complexes" by Frederick A. Lowenheim, Metal & Thermit Corp., Rahway, N. J. (Abstract No. 90)

10:40 A.M.--"Electrodeposition of Nickel" by J. P. R. Cels, Ernest Yeager, and Frank Hovorka, Dept. of Chemistry, Western Reserve University, Cleveland, Ohio. (Abstract No. 91)

11:05 A.M.--"Effect of Some Externally Imposed Factors on the Crystal Orientation in Electrodeposited Metals -- High Speed Rotation of Cathode and Presence of a Magnetic Field" by Ling Yang, Metals Research Lab., Carnegie Institute of Technology, Pittsburgh, Pa. (Abstract No. 92)

11:30 A.M.--"Polarography of Indium and Its Application" by G. H. Turner and J. A. Brown, Consolidated Mining and Smelting Co. of Canada Ltd., Trail, B. C. (Abstract No. 93)

11:45 A.M.--"An Electrical Phenomenon at Interfaces" by Joseph G. Barredo, Instituto de Quimica-Fisica Rocasolano, Consejo Superior de Investigaciones Cientificas, Madrid, Spain. (Abstract No. 94)

12:30 P.M.--Electrodeposition Division Luncheon and Business Meeting in Parlor A (Mezzanine).

ELECTRODEPOSITION (cont'd)
Electrodeposition from Nonaqueous Media
with M. L. Holt presiding
(Parlor A, Mezzanine)

2:00 P.M.--"Electrodeposition of Metals from Organic Solutions, I. Introduction" by Abner Brenner, National Bureau of Standards, Washington, D. C. (Abstract No. 95)

2:20 P.M.--"Electrodeposition of Metals from Organic Solutions, II. Further Studies on the Electrodeposition of Aluminum from the Hydride-Type Bath" by Jean Connor, National Bureau of Standards, Washington, D. C. (Abstract No. 96)

103-17

2:40 P.M.--"Electrodeposition of Metals from Or-

ganic Solutions, III. Electrodeposition of Titanium- and Zirconium-Aluminum Alloys" by Walter E. Reid, Jr., National Bureau of Standards, Washington, D. C. (Abstract No. 97)

3:00 P.M.--"Electrodeposition of Metals from Organic Solutions, IV. Electrodeposition of Beryllium and Beryllium Alloys" by Gwendolyn B. Wood, National Bureau of Standards, Washington, D. C. (Abstract No. 98)

3:30 P.M.--"Electrolytic Production of Coatings on Molybdenum from Fused Salts" by W. Beck and M. Ford, American Electro Metal Corp., Yonkers, N. Y. (Abstract No. 99)

4:00 P.M.--"Electrodeposition of Bismuth" by Kelso B. Morris, Dolores Z. Douglass, and Clarence B. Vaughn, Dept. of Chemistry, Howard University, Washington, D. C. (Abstract No. 100)

ELECTROTHERMICS AND METALLURGY

Wednesday, October 6, 1954

Round-Table Discussion
Safety in Handling Zirconium Powder
with W. M. Raynor presiding
(Parlor A, Mezzanine)

9:15 A.M.-11:30 A.M.--Round-table discussion presented by the Society's Committee for the Safe Handling of Zirconium Powder.

Part I--Members of the Committee will present briefly their experiences with zirconium powder to illustrate and explain the hazards involved in the handling of the metal.

Part II--Data sheet recommending what are considered the safest methods for the handling and packaging of zirconium powder will be presented.

Part III--Open discussion.

ELECTROTHERMICS AND METALLURGY (cont'd)
with J. M. Blocher, Jr., presiding
(Parlor A, Mezzanine)

2:00 P.M.--Keynote address--"The Bright Spark in the Metals Industry" by James D. Nisbet, Universal-Cyclops Steel Corp., Bridgeville, Pa. (Abstract No. 101)

2:25 P.M.--"Arc Melting in High Vacuum" by P. C. Rossin, Metallurgy Research Dept., General Electric Co., Schenectady, N. Y. (Abstract No. 102)

2:50 P.M.--"Vacuum Melting of High-Alloy Materials" by Howard R. Spendelow, Jr., and I. S. Servi, Metals Research Labs., Electro Metallurgical Co., New York, N. Y., and Glenn Fritzlen, Haynes Stellite Div., Union Carbide and Carbon Corp., Kokomo, Ind. (Abstract No. 103)

3:15 P.M.--"Impact Properties of Vacuum Melted Iron-Chromium Alloys" by J. L. Ham and F. L. Carr, National Research Corp., Cambridge, Mass. (Abstract No. 104)

3:40 P.M.--"Vacuum and Pressure Melting of Iron-Base Alloys" by E. R. Morgan and Donald Frey, Ford Motor Co., Dearborn, Mich. (Abstract No. 105)

4:05 P.M.--"Vacuum Induction-Melted Zirconium and Zirconium Alloys" by H. A. Saller, R. F. Dickerson, and E. L. Foster, Jr., Battelle Memorial Institute, Columbus, Ohio. (Abstract No. 106)

4:30 P.M.--"An Evaluation of Finely Divided Zirconium Powder" by Winston Bachmann and Richard H. Gale, Lamp Div., Chemical Products Works, General Electric Co., Cleveland, Ohio. (Abstract No. 107)

ELECTROTHERMICS AND METALLURGY (cont'd)

Thursday, October 7, 1954

with Arthur C. Haskell, Jr., presiding

(Parlor A, Mezzanine)

9:00 A.M.--"Design and Operation of an Induction and a Resistance Furnace for High Vacuum-High Temperature Applications" by R. F. Domagala and D. J. McPherson, Nonferrous Metals Research, Armour Research Foundation, Chicago, Ill. (Abstract No. 108)

9:25 A.M.--"A New Method for the Evaluation of High Vacuum Furnaces and Heat Treating Atmospheres" by W. R. McMillan and Earl A. Gulbransen, Westinghouse Research Labs., East Pittsburgh, Pa. (Abstract No. 109)

9:50 A.M.--"Theory and Performance Characteristics of a Kinney Mechanical Booster Vacuum Pump" by C. M. Van Atta and R. L. Sylvester, Kinney Manu-

facturing Div., New York Air Brake Co., Boston, Mass. (Abstract No. 110)

10:15 A.M.--"Rotary Gas Ballast Pumps" by William Frye, National Research Corp., Cambridge, Mass. (Abstract No. 111)

10:40 A.M.--"Economics of Vacuum Melting" by G. J. Crites, F. J. Stokes Machine Co., Philadelphia, Pa. (Abstract No. 112)

11:05 A.M.--"Deoxidation of Vacuum Melted M 252" by W. F. Moore and R. K. McKechnie, Research Labs., General Electric Co., Schenectady, N. Y. (Abstract No. 113)

11:30 A.M.--"Hydrogen Deoxidation of Vacuum-Melted High-Temperature Alloys" by R. L. Hadley and L. M. Bianchi, Research Labs., General Electric Co., Schenectady, N. Y. (Abstract No. 114)

ELECTROTHERMICS AND METALLURGY (cont'd)
with Ivor E. Campbell presiding
(Parlor A, Mezzanine)

2:00 P.M.--"Application of Vacuum Technology to Metallurgical Processes" by Robert G. Ulrech, Consolidated Vacuum Corp., Rochester, N. Y. (Abstract No. 115)

2:25 P.M.--"Vacuum Heat-Treating Techniques" by Richard L. Hoff and A. M. Bounds, Superior Tube Co., Norristown, Pa. (Abstract No. 116)

2:50 P.M.--"Solid State Purification of Molybdenum by Induction Heating" by J. E. Drennan, W. W. Kleinschmidt, and F. C. Todd, Electronics Physics Div., Battelle Memorial Institute, Columbus, Ohio. (Abstract No. 117)

3:15 P.M.--"Vacuum Degassing of Titanium" by C. B. Griffith and M. W. Mallett, Battelle Memorial Institute, Columbus, Ohio. (Abstract No. 118)

3:40 P.M.--"Vapor Pressures of Metals and Alloys" by Rudolph Speiser and J. W. Spretnak, Dept. of Metallurgy, Ohio State University, Columbus, Ohio. (Abstract No. 119)

4:15 P.M.--"Vapor Pressure Measurements in the Ca-Al System" by H. Hancock and L. M. Pidgeon, Dept. of Metallurgical Engineering, University of Toronto, Toronto, Canada. (Abstract No. 120)

4:40 P.M.--"Removal of Volatile Constituents from Nonferrous Alloys by Vacuum Distillation" by M. J. Spendlove, Secondary Metals Recovery Section, U. S. Bureau of Mines, College Park, Md. (Abstract No. 121)

ABSTRACTS

BATTERY--THEORETICAL ELECTROCHEMISTRY

Abstract No. 1

ELECTRODE KINETICS IN RELATION TO BATTERY PROCESSES

Ernest Yeager

Various types of rate-determining processes responsible for polarization are reviewed in terms of the electrode processes in primary and secondary batteries. Experimental as well as theoretical techniques involved in the study of electrode kinetics in batteries will be discussed. Practical results forthcoming from such efforts will also be emphasized.

Abstract No. 2

THERMODYNAMICS OF ELECTROCHEMICAL CELLS

Walter J. Hamer

Thermodynamic laws are most useful in defining systems at equilibrium. Some electrochemical systems cannot be made even approximately reversible under any practical condition. Such potentials are calculated from free energies or by a combination of cells of the reversible type. The speed of electronic reactions at electrodes is important in determining electrode reversibility. In general, electrode reactions not involving the rupture of formation of strong covalent bonds show or approach reversibility; those which involve such formation or rupture do not show reversibility. These factors will be reviewed in terms of some of the most commonly used batteries.

Abstract No. 3

MASS TRANSFER IN ELECTRODE REACTIONS

Carl Wagner

Transport of reactants and reaction products to and from electrodes takes place by means of electrolytic migration, diffusion, and convection of the solution. Typical cases are discussed in order to illustrate the interplay of the three kinds of transport and the practical consequences for elec-

trochemical processes, in particular, polarization, current efficiency, and the form of solid reaction products.

Abstract No. 4

RATE OF REACTION BETWEEN A POROUS SOLID AND A FLUID COMPONENT WITH DIFFUSION CONTROLLING

Howard J. Strauss

The discharge capacity of a battery decreases as the drain rate increases. This is generally attributed to the inability of reacting electrolyte components to diffuse to the reacting electrode surface at a rate sufficient to maintain the desired discharge. Fundamental diffusion equations have been developed for a porous solid reacting with a fluid component, and experimentally verified for a gas-solid reaction.

Abstract No. 5

BEHAVIOR OF INTERSTITIAL SOLUTES IN THE TRANSITION METALS

R. S. Dean and W. W. Gullett

Interstitial oxygen dissolved in titanium affects the voltage in molten alkali chloride. This voltage has been used to calculate the free energy of dilution of titanium by oxygen and permits conclusions as to the structure of this interstitial oxygen, and the mechanism of diffusion. It also holds promise for the investigation of other interstitial solutions.

Abstract No. 6

CATHODE PROCESSES IN ELECTROCHEMICAL CELLS

E. Willihnganz

Chemical reactions at the anode of electrochemical cells do not give a constant potential because the reactions are not completely reversible. There is always a slow step. Lead dioxide comes closest to being reversible at room temperature since it can be charged or discharged at a high rate without a major change in voltage. Other electrodes deviate farther from the reversible potential. These

Abstract No. 7

THE ELECTROCHEMISTRY OF MANGANESE DIOXIDE

W. C. Vosburgh

The electrochemistry of manganese dioxide is reviewed to describe known over-all chemical reactions and rate-determining steps which have been recognized.

Abstract No. 8

A FURTHER STUDY OF ELECTRODEPOSITED MANGANESE DIOXIDE ELECTRODES

W. C. Vosburgh, Richard S. Johnson,
John S. Reiser, and Douglas R. Allenson

Manganese dioxide electrodes prepared by electrodeposition on graphite when discharged in ammonium chloride electrolyte of pH 7.3 gave an oxide of composition $MnO_{1.6}$ and manganese(II) ion in solution. The electrical output was accounted for by these two products. Atmospheric oxygen had little effect.

Electrodes decreased slowly in potential on standing in electrolyte. The decrease was independent of the anion and of the presence or absence of oxygen, and indicated a loss of available oxygen.

Abstract No. 9

FORMATION OF MANGANESE(II) ION IN THE DISCHARGE OF THE MANGANESE DIOXIDE ELECTRODE

A. M. Chreitzberg, Jr., Douglas R. Allenson,
and W. C. Vosburgh

The rate of formation of manganese(II) ion in the discharge of electrodeposited manganese dioxide electrodes was studied and the effect on the rate of pH, current density, ammonium chloride concentration, and interruption of the discharge. A mechanism is suggested involving the assumption that the electrode reaction takes place at the dioxide-solution interface rather than the graphite-dioxide interface as assumed previously. Additional evidence is presented for this assumption.

Abstract No. 10

THE OVERPOTENTIAL OF THE MANGANESE DIOXIDE ELECTRODE

A. M. Chreitzberg, Jr., and W. C. Vosburgh

The overpotential of electrodeposited manganese dioxide electrodes can be measured with fair reproducibility and is a linear function of the logarithm of the ammonium ion concentration, but a more complex function of the logarithm of the apparent current density. Overpotential varies little with pH, but at pH 5 zinc ion increases it considerably. The bearing of these facts on the theory of the discharge mechanism is considered.

Abstract No. 11

CATHODE REACTIONS OF THE LECLANCHÉ DRY CELL

N. C. Cahoon, R. S. Johnson, and M. P. Korver

Reactions at the cathode of the Leclanché type dry cell are considered in terms of three heterogeneous chemical reactions, for which a plausible mechanism, leading to a unified theory of the cathode process, is advanced. When reviewed in terms of this theory, the numerous observations of others that formerly have appeared to be incongruous are correlated and rationalized in terms of the overall cathode reaction.

Abstract No. 12

LEAD DIOXIDE REACTIONS IN THE STORAGE BATTERY

E. Willihnganz

The primary charge-discharge reaction of the lead dioxide electrode appears to involve a surface film of oxygen atoms. During charge this oxygen is deposited on the lead dioxide particles as surplus oxygen which can subsequently react with lead ions. During discharge it is a deficiency of oxygen atoms equivalent to a conversion of the lead dioxide surface to a lower oxide. This hypothesis is based on charge and discharge behavior at -40°F.

Abstract No. 13

INFLUENCE OF METALLIC ADDITIONS UPON LEAD-ACID STORAGE BATTERY PERFORMANCE

Bernard Agruss

Oxides were produced from electrolytic lead to which had been added specific common metallic impurities. It appeared that these impurities influenced only the self-discharge rate and the end-of-charge voltage. Paste characteristics, rate of hydrosetting, formation, initial capacities, and S.A.E. life were not affected. The characteristic most sensitive to impurities was end-of-charge voltage. Impurities when combined appeared to have more than a simple additive effect.

Abstract No. 14

LEAD STORAGE BATTERY PERFORMANCE IN CAR SERVICE

Dudley Haskell

A field test of 32 automobile batteries is in progress to determine the effect of service life of some of the important variables in battery manufacture. Supplementary to this program, 11 control batteries were also tested on bench life tests for purposes of comparison. After 36 months about half of the batteries in car service are still in test. Most failures to date have been grid corrosion; manufacturing differences had practically no effect on battery life. Of most interest is the observation that relatively large amounts of bismuth (up to 0.15%) are not injurious to battery life.

Abstract No. 15

LEAD-ACID STORAGE BATTERIES--BARIUM SULFATE AS A POSITIVE PLATE CONTAMINANT

J. F. Dittmann and H. R. Harner

Barium sulfate in fractional percentages is regularly used in the active material of the negative plates of lead-acid storage batteries. At times, in preparing plates, some negative paste is accidentally mixed into positive paste, thus contaminating the positive paste with traces of barium sulfate. Rapid failure due to shedding has been traced to this barium sulfate contamination. Sys-

tematic tests show that as little as 0.0005% precipitated barium sulfate in positive paste markedly increases shedding on deep-cycling bench life-tests. On the other hand, as much as 0.1% had no evident effect in overcharge bench tests, or in actual car service.

Abstract No. 16

DETERMINATION OF THE INTERNAL RESISTANCE OF LEAD-ACID STORAGE CELLS

J. J. Lander and E. E. Nelson

A lead-acid cell was discharged through a resistance-inductance series circuit, and data were obtained which allowed an accurate and unequivocal determination of the internal resistance, because the early part of the voltage transient was free from contributions to polarization other than IR drop.

Other data show that, after concentration polarization is established, a second, but approximate method of measuring the resistance is possible.

Abstract No. 17

RESISTANCE AND POLARIZATION IN THE STORAGE BATTERY BY A-C BRIDGE METHODS

E. Willihnganz

The apparent resistance of an automobile type storage battery appears to be about 0.00105 ohm per cell at 80° when measured at 1000 cycles. At 60 cycles the resistance appears about 20% greater, and there is also an apparent capacitance of about 12 Farads per cell. This frequency effect is ascribed to a reaction at the lead-acid interface which does not appear to involve the lead ions.

Abstract No. 18

THE INTERNAL RESISTANCE OF PRIMARY AND SECONDARY BATTERIES AND ITS DETERMINATION

C. R. G. Drotschmann

The difficulties connected with the measurement of the internal resistance R_i of primary and secondary batteries are outlined. An explanation is

given as to why the IR-drop method is most unsuitable for obtaining satisfactory R_i values. Two new methods of measuring the R_i of both primary and secondary batteries are described. Both methods are suitable for laboratory research and factory control work.

Abstract No. 19

RESISTANCE STUDIES ON VARIOUS TYPES OF DRY CELLS

Richard Glicksman and C. K. Morehouse

A direct current method has been devised for measuring the internal resistance of dry cells. Data are presented which show that the internal resistance of a Leclanché type dry cell is greater when measured at low current drains than at high current drains. This difference is due to a film formation on the zinc anode.

It is also shown that during discharge the drop in terminal voltage of a dry cell due to an increase in internal resistance is small. It is believed that pH changes of the electrolyte at the electrode surfaces and the formation of solid solutions between manganese dioxide and a lower oxide of manganese account for most of the potential drop when a Leclanché cell is discharged.

Abstract No. 20

REACTIONS AT METALLIC ANODES IN PRIMARY AND SECONDARY CELLS: A REVIEW

N. C. Cahoon

Metals used as anodes in primary and secondary cells represent a group of materials with chemical properties covering a rather wide field. Important factors influencing their applications are discussed with the objective of presenting a general basis for rationalizing their operation.

Abstract No. 21

REACTIONS IN THE AIR DEPOLARIZED CELL: A REVIEW

E. A. Schumacher

A review is presented of the literature pertain-

ing to reactions occurring at the cathode of an air-depolarized cell and of the preparation and characteristics of carbons having oxygen sorbing properties. The anodic behavior of zinc in alkaline electrolyte and the equilibria in the systems: alkali-zinc oxide and zinc hydroxide-water are discussed in relation to cell behavior.

Abstract No. 22

ANODIC CORROSION OF ZINC IN ALKALI

T. P. Dirkse

A study has been made of the mechanism of the reaction taking place when zinc is anodically treated in potassium hydroxide solutions. The zinc-containing ion that is present in solution as a result of the anodic treatment is $Zn(OH)_4^{--}$. However, zinc oxide or zinc hydroxide appears to be an intermediate leading to the formation of $Zn(OH)_4^{--}$. This latter ion then decomposes slowly to form zinc oxide.

Abstract No. 23

THEORETICAL STANDARD ELECTROMOTIVE FORCES FOR CELLS CONTAINING A SINGLE SOLID OR MOLTEN HALIDE ELECTROLYTE

Walter J. Hamer, Marjorie S. Malmberg, and Bernard Rubin

Standard electromotive forces have been calculated from thermodynamic data for reversible galvanic cells of the type $M/MX_n/X_2$, where M is a solid, liquid, or gaseous metal, X_2 is gaseous chlorine, bromine, or fluorine at one atmosphere, and MX_n is their salt in the solid or liquid state. The emfs were computed for 13 temperatures between 25° and 1500°C. Three new electrochemical series for the solid or fused electrolytes have been derived and are compared to the corresponding aqueous systems.

Abstract No. 24

NUCLEAR BATTERIES

William Shorr

The nuclear battery device offers a direct means of converting nuclear energy to electrical energy

and may be produced in many ways. The processes which have been successfully reduced to practice may be characterized as belonging to one of three general types: 1. constant current charging; (a) primary current collecting with solid dielectric, (b) primary current collecting with vacuum dielectric, and (c) secondary emission with vacuum dielectric; 2. gas ionization; 3. current miltiplication with p-n junction.

BATTERY

Abstract No. 25

A METHOD OF PLASTIC IMPREGNATION FOR THE INVESTIGATION OF STORAGE BATTERY FAILURE

A. C. Simon and E. L. Jones

A method is described wherein failed batteries are plastic impregnated, sectioned, and polished. Microscopic inspection of such sections reveals much information concerning the mechanisms of battery operation and failure. Examples are given of some of the factors that may be determined by such a method.

Abstract No. 26

FURTHER STUDIES ON THE ANODIC CORROSION OF LEAD IN SULFURIC ACID SOLUTIONS

J. J. Lander

Data for the constant-potential corrosion of lead in sulfuric acid solutions of several strengths have been obtained at potentials which correspond to those of the positive plate of the lead-acid cell on charge, on stand, and on discharge. Corrosion rates increase in a nearly logarithmic fashion as the potential falls in going from charge to discharge. Results are interpreted both in terms of the electrochemical reactions which may occur and in terms of battery life under different types of service.

Abstract No. 27

ANODIZATION OF LEAD IN SULFURIC ACID

Jeanne Burbank

Anodic corrosion products formed on lead in sulfuric acid solutions depend upon the potential of the metal surface.

Between the lead/lead sulfate and lead sulfate/lead dioxide potentials, basic sulfates and lead monoxide have been identified by electron diffraction.

Coordinated potential-time studies show arrests corresponding to the appearance of these compounds. The physical nature of these films is discussed.

Abstract No. 28

RAPID CORRODIBILITY EVALUATION OF LEAD-ACID STORAGE CELL POSITIVE GRID ALLOYS

James F. McGivern, Jr.

A brief history of rapid evaluation of positive grid alloy corrodibility is presented. It is shown how innovations in data manipulation make old test data more meaningful and how physical testing may replace corrosion tests in special cells or batteries. A method for easy and accurate determination of Young's Modulus is described, and equations relating density and specific electrical resistivity to antimony concentration in the Pb-Sb binary system are offered.

Abstract No. 29

A RAPID TEST FOR SULFATION

C. C. Rose

Lead-acid storage batteries are subject to early failure by operation or storage in a condition of partial discharge. This type of failure is commonly called sulfation. It has not been defined accurately and has been difficult to produce and evaluate in the laboratory. A method is proposed which is fairly rapid, consistent, and significant, and which measures the contribution of various factors involved.

Abstract No. 30

ROLE OF INVERSE SEGREGATION AND REDISTRIBUTION OF SOLUTE ATOMS IN THE FREEZING OF HYPOEUTECTIC LEAD-ANTIMONY ALLOYS

A. C. Simon and E. L. Jones

The excessive amount of antimony at the surface of lead-antimony castings, which increases toward 100% as the antimony increases toward 11%, is attributed to the combined effects of metal shrinkage during freezing, interdendritic flow of still molten metal from the interior to the shrinkage gap, and supersaturation of antimony in the resultant antimony-enriched composition at the surface which allows continued precipitation of lead instead of eutectic.

Abstract No. 31

COLOR CHANGES IN LEAD OXIDES WITH CHANGES IN TEMPERATURE*

Everett J. Ritchie and Paul E. Jensen

Changes in color which lead oxides undergo when heated have been measured for three lead oxide preparations over the temperature interval 75°K to 960°K on a G.E. recording spectrophotometer using special sample holders in which the sample could be cooled or heated without removing from the spectrophotometer. Data have been analyzed on the basis of the shift in absorption with changes in temperature. Changes in absorption are related to the crystal structure of the oxides and their thermal stability.

Abstract No. 32

SEALED NICKEL-CADMIUM CELLS

Ernst G. Baars

Commercially available sealed nickel-cadmium cells and experimental models designed and constructed at the Signal Corps Engineering Laboratories have been investigated. Capacities, rates of self-discharge, and gas evolution, etc., have

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* This work was done under ONR Research Contract Nonr-512(00).

been checked under varying conditions of charge and discharge. An attempt is being made to determine the reaction mechanism enabling these cells to function in a tightly sealed condition. An understanding of this mechanism will result in establishing assets and limitations of sealed cells.

Abstract No. 33

GASSING OF DRY CELLS

Earl Otto and Woodward G. Eicke, Jr.

A satisfactory method and suitable apparatus for determining the rate of gassing of dry cells are described. Gassing rates, ranging from 0.02 to 8 ml/day, have been obtained at +21°, +35°, +45°, and +55°C. Some analyses have been made of the gases evolved. A few cells have been discharged while in the gasometers. A comparison of the drop in voltage with the rate of gassing is shown. An interpretation of results is attempted.

Abstract No. 34

EFFECT OF LOW TEMPERATURE STORAGE UPON THE SHELF-LIFE CHARACTERISTICS OF DRY BATTERIES

Charles H. Clark

Previous investigations have shown that delayed capacity characteristics of dry cell batteries could be improved through the use of storage at temperatures as low as 0°F. It had been reported that storage at temperatures below the freezing point of the dry cell electrolyte resulted in erratic and inferior capacity retention. Recent tests have proved that still further improvement in shelf-life performance can be attained through the use of storage at -40° and -65°F.

Abstract No. 35

A FILM LINING FOR HIGH CAPACITY DRY CELLS

N. C. Cahoon and M. P. Korver

A reaction between cereal paste and electrolytic MnO_2 is shown to be responsible for serious deterioration in high-capacity dry cells. A method is presented for selecting a colloid suitable for use as a nonreactive separator medium. Film linings, prepared from methyl cellulose, chosen by the

method given, are described. Data show that cells prepared with properly selected films possess high initial capacity together with a keeping quality far surpassing that made with cereal paste.

Abstract No. 36

EFFECT OF HIGH TEMPERATURE STORAGE ON THE STABILITY OF BATTERY-GRADE MANGANESE DIOXIDE

Arthur F. Daniel

Samples of various types of both synthetic and natural manganese dioxide were stored at various temperatures and humidities for 12 months. Every six months each material was subjected to chemical and microstructural evaluation and battery capacity evaluation test. Twelve months' storage up to 130°F did not affect the characteristics of the manganese dioxides. However, storage at 160°F did result in a change in the properties of several of the samples, particularly the chemically prepared types.

CORROSION

Abstract No. 37

INTRODUCTORY REVIEW OF THE PROBLEM

J. J. Harwood

(No abstract available)

Abstract No. 38

FRACTURE MECHANICS

E. Orowan

(No abstract available)

Abstract No. 39

CRYSTALLOGRAPHY AND CORROSION CRACKING

W. D. Robertson

(No abstract available)

Abstract No. 40

STRESS CORROSION OF HOMOGENEOUS ALLOYS

L. Graf

(No abstract available)

Abstract No. 41

GRAIN BOUNDARY STRUCTURE

Bruce Chalmers

(No abstract available)

Abstract No. 42

METALLURGICAL ASPECTS OF STRESS CORROSION IN ALUMINUM ALLOYS

E. C. W. Perryman

(No abstract available)

Abstract No. 43

ROLE OF SURFACE ADSORPTION OF SOLUTE ATOMS IN STRESS CORROSION OF ALLOYS

Rudolph Speiser and J. W. Spretnak

(No abstract available)

Abstract No. 44

STRESS CORROSION OF AUSTENITIC STAINLESS STEEL

C. Edeleanu

(No abstract available)

Abstract No. 45

OCCLUSION OF HYDROGEN IN IRON AND ITS ALLOYS

W. R. Heller

(No abstract available)

Abstract No. 46

HYDROGEN EMBRITTLEMENT

W. M. Baldwin

(No abstract available)

Abstract No. 47

CAUSTIC AND NITRATE CRACKING OF STEEL

R. N. Parkins

(No abstract available)

Abstract No. 48

LABORATORY INVESTIGATION TECHNIQUES RELATING TO STRESS CORROSION CRACKING

H. R. Copson

(No abstract available)

Abstract No. 49

AN INTERPRETATION OF THE SIGNIFICANCE OF THE POTENTIALS OF PASSIVE IRON

M. J. Pryor

Steady-state values of the passive potential of iron in anodic inhibitors forming hydrated oxide corrosion products with ferrous ions decrease with increasing pH and with increasing inhibitor concentration. Values of passive potentials in phosphate solutions increase with increasing pH. Effects of surface pretreatment and of the addition of small amounts of chloride on the passive potentials are more pronounced at high pH values. Increasing oxygen concentration of solutions results in a shift in potential in the more noble direction. An explanation of these effects based on the oxide film theory of anodic inhibition is advanced.

Abstract No. 50

ELECTROCHEMICAL BEHAVIOR OF IRON IN OXYGEN FREE ACID ENVIRONMENTS

Milton Stern and Herbert H. Uhlig

Several investigators have reported that the potential behavior of iron is similar to that of a hydrogen electrode in acid environments--that is, the corrosion potential varies by 59 mv for each unit pH change.

Corrosion rates, potentials, and polarization measurements are used to explain this behavior. A method is described for calculation of corrosion rates from electrochemical measurements alone. The limitations and environmental conditions required for this method are discussed. The effects of a variety of alloy additions are described and explained in terms of hydrogen overvoltage.

Abstract No. 51

NATURE OF FILM ON IRON PASSIVATED BY NITRIC ACID

Herbert H. Uhlig and Thomas L. O'Connor*

Results are reported on effects of pre-exposing evaporated iron films to oxygen, nitrites, chromates, and ferrates on the amount of iron reacting in concentrated nitric acid before the metal becomes passive. These confirm an electrochemical mechanism. By use of alloyed chromium as tracer, it was established that the film substance contains hexavalent metal ions, and is strongly oxidizing. These facts, combined with potential measurements, allow certain conclusions to be made regarding composition of the passive film.

Abstract No. 52

CORROSION INHIBITORS AND POLAROGRAPHIC MAXIMA

Harry C. Gatos

Polarization phenomena occurring in corrosion and polarographic processes are compared, and certain similarities are pointed out. On this basis, results of polarographic studies of a number of corrosion inhibitors are presented, particularly for the iron-sulfuric acid system. The effectiveness of "adsorption inhibitors" in suppressing polarographic maxima is a function of concentration resembling adsorption isotherms. Polarography is suggested as a valuable tool in corrosion inhibitor studies.

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Abstract No. 53

A THEORETICAL BASIS FOR A NEW METHOD OF INVESTIGATING CORROSION INHIBITION

J. O. Jewell

An inequality is derived that bounds the derivative of the corrosion current with respect to concentration of a cathodic inhibitor. The inequality, a consequence of a generalization of Muller's model of corrosion, involves only measurable quantities: a resistance and derivatives of the metal potential with respect to inhibitor concentration and external current at zero external current. The mathematical relationship makes possible inferences concerning the effectiveness of cathode polarizers and suggests possible means for screening inhibitors.

Abstract No. 54

EFFECT OF OXYGEN, CHLORIDES, AND CALCIUM ION ON CORROSION INHIBITION OF IRON BY POLYPHOSPHATES

Herbert H. Uhlig, D. N. Triadis, and Milton Stern

Sodium polyphosphates are effective corrosion inhibitors for steel in the presence of dissolved oxygen, but accelerate corrosion in its absence. Calcium ions appreciably improve inhibition under all conditions. Potential and polarization data indicate that corrosion control in presence of calcium is mixed. Mechanisms are discussed.

Abstract No. 55

CONTRIBUTION TO THE THEORY OF ELECTROPOLISHING

Carl Wagner

An ideal electropolishing process is characterized by a plateau of the current density-potential curve corresponding to the maximum diffusion rate of an acceptor for metal ions toward the anode. Such a process is amenable to a quantitative theoretical analysis. Formulas are derived for the decrease of surface roughness as a function of the recess of the average surface, the amount of metal dissolved per unit surface area, and the product of

current density and time.

Abstract No. 56

THE MECHANISM OF METALLOGRAPHIC ETCHING
I. Reaction Potentials of a Two-Phase Brass in Various Etching Reagents

George L. Kehl and Max Metlay*

Potentials generated by reaction of portions of small single grains of each of the two phases of alpha-beta brass with various etching solutions have been measured. The potential of the beta phase is consistently 0.01 to 0.03 v more anodic than that of the alpha phase in the same reagent.

Abstract No. 57

THE MECHANISM OF METALLOGRAPHIC ETCHING
II. Current-Potential Relationships during Etching of a Two-Phase Brass in Various Reagents

Max Metlay* and George L. Kehl

By means of two measuring techniques, the current flow between isolated portions of the phases in alpha-beta brass have been determined while undergoing etching in a variety of etching reagents. It is found that the current is essentially constant for a thousandfold range of values of the external resistance. The polarization behavior of the cells is that exhibited by corrosion systems under mixed control.

Abstract No. 58

CRYSTALLOGRAPHIC DEPENDENCE OF
THE OXIDATION POTENTIAL OF COPPER

W. E. Tragert and W. D. Robertson

The oxidation potentials of solid copper crystals have been evaluated for the isolated crystallographic planes, (111), (110), (100), (210). It has been demonstrated that the only stable surface configuration of atoms is that of the close-packed

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octahedral plane and, accordingly, only this plane on the electrode surface produces a reversible cell. The significance of potentials obtained with other forms of electrodes have been interpreted on the basis of the observed crystallographic requirement for equilibrium.

Abstract No. 59

THE FORMATION OF ANODIC OXIDE FILMS ON CATHODES

D. A. Vermilyea

The total voltage applied across an anodic film during its formation consists of the voltage applied to the cell minus any polarization voltage at the cathode and resistive drop in the electrolyte plus the potential of the electrochemical reaction. It is shown that because of the latter potential it is possible to form an oxide film on tantalum even when the tantalum is considerably negative with respect to a hydrogen electrode.

Abstract No. 60

FUNDAMENTAL THERMODYNAMICS AND KINETICS OF ELECTRODE PROCESSES

Pierre Van Rysselberghe

Expressions for anodic and cathodic reaction velocities are written in terms of electrochemical and chemical potentials of the reacting species and of the reaction complexes. Conditions bringing about coincidence with Tafel expressions are analyzed and rational definitions of the transfer coefficients are established. The so-called exchange currents are discussed. The limiting case of small overvoltages is examined. The case of hydrogen overvoltage is presented as an example of the proposed theory.

Abstract No. 61

CORROSION INHIBITION AND CATHODIC PROTECTION EXAMINED FROM THE POINT OF VIEW OF THE THERMODYNAMICS OF IRREVERSIBLE PROCESSES

Pierre Van Rysselberghe

The thermodynamics of irreversible processes includes a theory of stationary states of minimum

entropy production which can be regarded as a generalization of the Le Chatelier principle for the case of equilibrium. This theory, when applied to simultaneous electrochemical processes, and in particular to those involved in corrosion and in its prevention, leads to interesting conclusions with possible useful applications. These considerations are limited to the range of linearity between currents and overvoltages.

Abstract No. 62

CODEPOSITION EXAMINED FROM THE POINT OF VIEW OF THE THERMODYNAMICS OF IRREVERSIBLE PROCESSES

Pierre Van Rysselberghe

When two electrochemical processes occur simultaneously at the same electrode at potentials close to the reversible ones, a linear relation can be set up between the partial current of each process and the two overvoltages. The mutual drag coefficients can be expected to obey Onsager's symmetry principle. Discussion of these linear relations leads to considerable clarification of the conditions under which codeposition, regarded as a case of thermodynamic coupling, can be expected to occur.

Abstract No. 63

THE ISOLATION OF SURFACE FILMS FROM ALUMINUM AND ITS ALLOYS

M. J. Pryor and D. S. Keir

Warm solutions of iodine in methyl alcohol have been found to be satisfactory for isolating surface films from aluminum alloys not containing copper. Small additions of sulfosalicylic acid to these solutions render them satisfactory for isolating surface films from aluminum-copper alloys. Attack of these solutions is not selective at the film-aluminum interface so that all the aluminum must be dissolved before uncontaminated films can be obtained. Hydrogen evolved during dissolution of the aluminum is due to the formation of aluminum methoxide. Aluminum iodide also forms in these solutions. One of these reaction products, aluminum methoxide, is insoluble in anhydrous solutions but is decomposed by traces of water. A mechanism for its dissolution of aluminum in this solution is suggested.

Abstract No. 64

THE ANODIC TREATMENT OF ALUMINUM IN SULFURIC ACID SOLUTIONS

Roy C. Spooner

High purity aluminum was anodized in sulfuric acid solutions at various concentrations (5-50%), temperatures (10°-50°C), time periods (2-60 min.), and current densities (1.7-6.2 amp/dm^2). Coating weight, metal loss, coating ratio, sealing weight gain, dyed color, and density coating chemical dissolution rate were determined. The coating ratio at zero metal loss and its possible use to determine the extent of various anodic reactions are discussed.

Abstract No. 65

DEPOLARIZED DISSOLUTION OF IRON IN ACID SOLUTION I. Potential-Current Density Relationships

A. C. Makrides, N. M. Komocromos, and Norman Hackerman

Iron dissolves in "air-free" 0.05N-2.0N HCl at a rate independent of rotational speed at linear velocities up to 50,000 cm/min. The rate is linearly dependent and the dissolution potential is a logarithmic function of the activity of the HCl. With depolarizers added, the dissolution rate increases regularly with rotational speed and, at constant HCl, the dissolution potential varies according to the logarithm of the mean dissolution current density. It is shown theoretically that the equation for the dissolution potential in the presence of depolarizer is equivalent to a polarization equation for the anodic reaction.

Abstract No. 66

STAINLESS STEEL IN FERRIC CHLORIDE SOLUTION. EXPLORATORY EXPERIMENTS

Herman A. Liebhafsky and Arthur E. Newkirk

Pitting of Type 302 stainless steel by ferric chloride has been explored by measuring the rate at which immersed, suspended coupons lose weight. Results are unexpectedly reproducible and show several features of unusual interest. After a short

induction period, the corrosion reaction proceeds at an increasing rate and terminates abruptly when only about 2% of the sample remains. A systematic study of the corrosion reaction, which should extend our knowledge of pitting, can now be undertaken.

Abstract No. 67

KINETICS OF THE CORROSION OF COPPER IN ACID SOLUTIONS

John R. Weeks* and George R. Hill

The mechanism of the initial corrosion of copper in hydrochloric acid solutions was investigated, using a radioactive tracer technique. Kinetic data were obtained showing the effect of pH, dissolved oxygen, chloride ion, and temperature on the corrosion rate. Surface areas were measured using a modified electrolytic method. On the basis of these data, a mechanism for the initial corrosion process is proposed and discussed.

Abstract No. 68

THE DIFFERENCE EFFECT ON ALUMINUM DISSOLVING IN HYDROFLUORIC AND HYDROCHLORIC ACIDS

M. E. Straumanis and Y. N. Wang

Purest aluminum dissolves in HF with only a slightly lower rate than purest titanium in the same acid. Like titanium, aluminum displays the positive difference effect if an anodic current passes through aluminum while the metal is dissolving in hydrofluoric acid. The effect is proportional to the current density and nearly independent of the concentration of the acid.

As aluminum dissolving in hydrochloric acid shows the negative difference effect, the latter was studied in detail in six different concentrations of HCl. At low current densities the effect in HCl is positive, but changes to the negative one at higher current densities. The effect varies with current density along a curve and is seemingly independent of the concentration of the acid. Attempts are made to explain both effects from the standpoint of local currents.

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Abstract No. 69

THE CORROSION OF ALUMINUM IN POTASSIUM CHLORIDE SOLUTIONS

W. Beck,* F. G. Keihn,**
and R. G. Gold***

Weight loss and electrode potential of aluminum specimens were recorded in 0.0001N to 1N KCl solutions. Oxygen concentration was varied either by bubbling this gas through the solution or by increasing its partial pressure. Weight loss increased with higher oxygen concentration, but it decreased with higher electrolytic concentration. This phenomenon, which was not brought about by formation of the accelerator H_2O_2 or by diminishing oxygen solubility with higher electrolytic concentration, was related to cathodic processes.

Abstract No. 70

THE OXIDATION OF IRON-MOLYBDENUM ALLOYS

S. S. Brenner

Binary alloys of iron and molybdenum up to 20% molybdenum do not exhibit "catastrophic oxidation," up to 1000°C, neither in stationary nor in flowing atmospheres. Molybdenum significantly decreases the oxidation rate of iron. MoO_2 and iron molybdate are formed at the metal-oxide interface. This prevents the formation of the cation deficient FeO, normally found on iron oxidized at elevated temperatures.

Abstract No. 71

THE OXIDATION OF NICKEL-MOLYBDENUM ALLOYS

S. S. Brenner

Nickel-molybdenum alloys containing up to 30%

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nickel were oxidized at 800° to 1000°C. Oxidation produced an outer scale of NiO and $NiMoO_4$ and a subscale of MoO_2. Molybdenum affects the oxidation rate of nickel only to a small extent. Up to 5% the oxidation rate is increased, while beyond 20% molybdenum the rate is again decreased. A mechanism for the oxidation is postulated.

Abstract No. 72

THE CATASTROPHIC OXIDATION OF SOME MOLYBDENUM CONTAINING ALLOYS

S. S. Brenner

When nickel or chromium are added to iron-molybdenum alloys, catastrophic oxidation occurs in certain concentration regions. Chromium is much more potent than nickel in inducing this rapid type of oxidation.

Catastrophic oxidation occurs by the formation of liquid MoO_3 along the metal-oxide interface. The formation of liquid MoO_3 is preceded by the cracking of the chromium or nickel containing oxide.

Catastrophic oxidation does not occur with alloys containing large amounts of nickel.

Abstract No. 73

KINETICS OF THE REACTION OF HYDROGEN WITH ZIRCONIUM*

Jack Belle, B. B. Cleland, and M. W. Mallett

The rate of reaction of hydrogen with high-purity zirconium was determined for the temperature range of 250°-425°C at 1 atm pressure. The reaction was found to follow a parabolic law, and the parabolic rate constant in $(ml/cm^2)^2/sec$ was calculated to be $k = 2.3 \times 10^5 e^{-17,200/RT}$ where 17,200 ± 200 cal/mole is the activation energy for the reaction.

Abstract No. 74

KINETICS OF THE HIGH TEMPERATURE OXIDATION OF ZIRCONIUM*

Jack Belle and M. W. Mallett

* Work performed under AEC Contract W-7405-eng-92.

The rate of oxidation of high-purity zirconium was determined for the temperature range of 575° to 950°C at 1 atmosphere pressure. The data can be fitted to a cubic law and the rate constant in $(ml/cm^2)^3$ per second has been calculated to be $k = 3.9 \times 10^6 e^{-47,200/RT}$, where 47,200 ± 1000 cal/mole is the activation energy for the reaction.

ELECTRODEPOSITION

Abstract No. 75

BRIGHTENING AGENTS FOR THE TIN-II SULFATE-SULFURIC ACID ELECTROLYTE

C. A. Dischar* and F. C. Mathers

Addition agents are named which are capable of producing specular deposits directly from the acid tin plating bath. Concentration ranges of electrolyte and operating conditions are discussed. Properties of the electrodeposit are described. The role played by each of the addition agents is discussed.

Abstract No. 76

ELECTRODEPOSITION OF LEAD FROM LEAD PHENOL SULFONATE SOLUTIONS

F. C. Mathers and Harry C. Gatos**

Various addition agents were tested in a lead phenol sulfonate bath. A combination of cresol, goulac, and aloin residue gave smooth, solid lead deposits. Experimental results seem to confirm the view that, in some way, favorable results depend, among other things, upon the presence of complex cations.

Although Betts originally theorized that firm lead deposits could be obtained only from salts of strong acids, researches have now shown that good deposits can be obtained from baths of most lead salts.

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Abstract No. 77

ELECTRODEPOSITION OF RHODIUM

Edward A. Parker

Factors affecting the deposition of rhodium in thicknesses of 0.000001 to 0.001 in. were studied. The simple sulfate concentrate plus sulfuric acid gave the best over-all results with respect to higher current efficiency, brightness and smoothness of plate, and less sensitivity to additions of other salts and impurities. Added metallic impurities Ni, Cu, Cd, Pb, Ag, and Sn with the exception of nickel produced harmful effects in concentrations less than 10 mg/l. Addition of E D T A to contaminated solutions even at pH of 0.5 had some beneficial effects.

Methods of purification are discussed. Applications which depend on decorative white finish, hardness, corrosion resistance, optical reflectivity, low electrical resistance, and combinations are discussed.

Abstract No. 78

ELECTROLESS NICKEL PLATING OF INTERNAL ALUMINUM SURFACES

P. H. Eisenberg and H. I. Raiklen

Internal surfaces of aluminum tubes were nickel plated by the electroless method. Suggested plating mechanisms are discussed and deposition rates and conditions are reported. Tests on the nickel plate include: x-ray diffraction, spectrographic, and wet chemical analyses; porosity; mechanical properties; and metallographic examinations.

Abstract No. 79

ZINCALOY--A NEW SOLDERABLE ZINC ALLOY PLATING PROCESS

E. B. Saubestre

Zincaloy is a new plating process which provides, for the first time, an inexpensive, solderable, rust-resistant coating. It confers the corrosion protection of zinc and the solderability of tin or cadmium at a price only slightly greater than that of zinc.

In order to deposit an alloy with these properties it was necessary to develop a new type of plating solution and a procedure for operating with soluble alloy anodes. The zincaloy bath combines conventional tin and zinc plating solutions in an unconventional manner.

Abstract No. 80

USE OF A FRACTIONAL FACTORIAL EXPERIMENT TO STUDY A MANGANESE-TIN ALLOY PLATING BATH

W. C. Schickner and A. B. Tripler, Jr.

A fractional factorial experiment proved to be an effective means of exploring the behavior of a manganese-tin alloy plating bath. According to an interpretation of an analysis of variance, 12 variations of the bath and conditions of use had prospects for producing plates of good quality. Plating trials, according to the 12 variations, verified this finding.

The per cent tin by chemical analysis of alloys from these plating baths and cathode current efficiencies agreed within expected tolerances with estimates from analyses of variance. Analysis of variance revealed no combination of conditions for improving the efficiency above 10%.

Abstract No. 81

ELECTRODEPOSITION OF NICKEL AT A MERCURY CATHODE

J. T. Funkhouser and L. B. Rogers

The deposition behavior of nickel onto a mercury pool from a thiocyanate solution was studied by means of electrolyses at constant potentials. When the per cent deposited was plotted against time, an induction period was observed under a variety of conditions. The induction period, which appears to be due to slow deposition of nickel upon mercury followed by faster deposition onto nickel, was studied under various experimental conditions.

Abstract No. 82

SEPARATIONS WITH A MERCURY ELECTRODE
Determination of Certain Metallic Impurities in Vanadium Salts

William E. Schmidt and Clark E. Bricker

By means of an electrolysis with a mercury cathode, microgram quantities of copper, lead, cadmium, zinc, iron, cobalt, and nickel can be separated from at least 0.5M vanadium solutions. The quantitative recovery of all of these traces of metals except cadmium from the mercury by distillation is satisfactory, and the subsequent estimation of all these metals by either polarographic or spectrophotometric methods is adequate.

The use of electrolytic stripping of dilute amalgams at controlled potentials shows that electrodeposited metals could not only be separated into the two major groups of passive (Fe, Co, and Ni) and nonpassive (Cu, Pb, Cd, and Zn) metals, but that separations within the nonpassive group are also possible.

Abstract No. 83

EFFECT OF TEMPERATURE CHANGES ON THE POLAROGRAPHIC WAVES OF THALLOUS, CADMIUM, AND COBALTOUS IONS*

J. F. Murphy

The polarographic behavior of Tl^{+}, Cd^{++}, and Co^{++} in perchlorate supporting electrolyte has been investigated at two concentrations for temperatures from 0° to $45^{\circ}C$. $E_{1/2}$ is independent of temperature for thallous and cadmium ion reduction, as expected. $E_{1/2}$ becomes more positive with increasing temperature for Co^{++} in agreement with the irreversible form of the wave. Temperature coefficients of the diffusion currents are evaluated and compared with theory.

Abstract No. 84

PERMEATION OF GASES THROUGH ELECTROLYTIC NICKEL DEPOSITS
I. Determination of the Intrinsic Permeability of Nickel Deposits to Gases

D. T. Ewing, J. Martin Tobin, and D. Gardiner Foulke

By reducing the systematic errors involved in

* This work performed at the Department of Chemistry, University of Idaho, Moscow, Idaho.

measuring the permeability of detached nickel electrodeposits, it is possible to obtain measurements of the rate of flow of gases through a deposit with a good degree of reproducibility. Nickel deposits obtained with a Watts bath were found to be relatively impervious to the permeation of gases even in the case of the thinnest deposits, about 0.00005 in. thickness.

By comparing the rate of flow of hydrogen and helium gases, some information can be obtained on the nature of the pores through which the gases flow.

Abstract No. 85

PERMEATION OF GASES THROUGH ELECTROLYTIC NICKEL DEPOSITS

II. Determination of the Effect of Several Variables upon the Intrinsic Permeability of Nickel Deposits to Gases

D. T. Ewing, J. Martin Tobin, and
D. Gardiner Foulke

The conditions of temperature, current density, and pH used when plating from the Watt's bath were each varied independently in order to determine the effect on the intrinsic permeability of the deposits.

The nickel and boric acid concentrations of a Watts bath were studied similarly. The effect of various addition agents which tend to produce bright deposits were also determined. Several bath impurities were studied with respect to their effect on intrinsic permeability of nickel deposits.

Abstract No. 86

PRODUCTION OF HIGH-PURITY COBALT

K. K. Kershner, F. W. Hoertel, and J. C. Stahl

Cobalt of more than 99.95% purity is produced by electrolytic deposition. Cobalt solutions are purified for electrolysis by ion exchange resins, chelating agents, and controlled cathode potentials.

Abstract No. 87

CATALYSIS OF ELECTRON TRANSFER REACTIONS*

J. F. Murphy

Available experimental evidence shows that electron transfer reactions, both between simple positive ions in solution and between simple positive ions and cathodes, are facilitated by the formation of an electron-conducting bridge between the electron exchanging species. Both electrode and positive ion must act as Lewis acids. The catalytic effectiveness of the bridging ion is shown to depend on its polarizability and on its ability to form complexes with the metal ion.

Abstract No. 88

A THEORY OF CHROMIUM PLATING FROM CHROMIC ACID SOLUTION BASED ON DYNAMIC CELL MEASUREMENTS

Arthur A. Burr

Dynamic measurements of cell current and overvoltage made on chromium plating cells have been converted to heats and free energies of activation for the cathode processes according to procedures already described.** Effects of sulfate ion and trivalent chromium ion content of the electrolyte have been studied. From these results possible mechanisms for the cathode processes have been chosen.

The possibilities of a special inclined cathode test cell have been explored and results correlated with other dynamic cell measurements.

By means of periodic chemical analysis of the electrolyte from cells operated under progressively changing cell variables and by the use of radioactive trace techniques, the most probable plating mechanism has been chosen. Based on this mechanism, predictions as to possible means for improving the efficiency of the plating process are made.

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* This work was performed at the Department of Chemistry, University of Idaho, Moscow, Idaho.

** D. G. Rogers and A. A. Burr, J. Electrochem. Soc., 97, 92 (1950).

Abstract No. 89

MASS SPECTROMETRIC EXAMINATION OF HYDROGEN IN CHROMIUM PLATED STEEL

Charles Levy and George A. Consolazio

Specimens of chromium plated mild steel were examined for hydrogen in the mass spectrometer. Relative amounts of hydrogen evolution were measured on a time-temperature basis. Temperatures ranged from 25° to 800°C. Data are presented which show total hydrogen evolved in arbitrary units as a function of time at constant temperatures. Steel specimens and chromium plated specimens of the same steel were compared as to relative hydrogen contents by two methods.

Abstract No. 90

INFLUENCE OF THE TRANSFERENCE NUMBER IN PLATING FROM ANIONIC COMPLEXES

Frederick A. Lowenheim

Migration phenomena have been generally considered to be of little or no importance in practical electrodeposition, since it is assumed that diffusion and convection are far more important in bringing metal ions up to the cathode. This paper is a preliminary attempt to point out that, although diffusion, stirring, etc., undoubtedly govern movement of ions in the bulk of the solution, transference must still be taken into account in the electrode layer; experimental results of a study of potassium vs. sodium in various anionic-complex plating baths are qualitatively interpreted on this basis.

Abstract No. 91

ELECTRODEPOSITION OF NICKEL*

J. P. R. Cels, Ernest Yeager,
and Frank Hovorka

The polarization associated with the electrodeposition of nickel has been determined at various temperatures in simple sulfate and chloride solutions with a flow of solution directed past

* Research partially supported by a fellowship from the Harshaw Chemical Company to one of the authors (J. P. R. C.).

the electrode to obtain reproducible concentration gradients. From efficiency measurements, polarization curves have been obtained for the individual nickel and hydrogen discharge processes. The structure of deposits has been examined with x-ray diffraction techniques.

Abstract No. 92

EFFECT OF SOME EXTERNALLY IMPOSED FACTORS ON THE CRYSTAL ORIENTATION IN ELECTRODEPOSITED METALS--HIGH SPEED ROTATION OF CATHODE AND PRESENCE OF A MAGNETIC FIELD

Ling Yang

Crystal orientations prevailing in metals electrodeposited on stationary cathode could be destroyed, modified, or unchanged when the cathode was rotated at 3000 rpm, depending upon the effect of the forced convection of the rotation on the amount of codeposited hydrogen. The presence of a magnetic field of 5400 gauss strength, either perpendicular or parallel to the cathode, had no effect on the types of crystal orientation in Fe, Ni, and Co deposits. However, the surface of the deposits became very rough when the field was perpendicular to the cathode.

Abstract No. 93

POLAROGRAPHY OF INDIUM AND ITS APPLICATION

G. H. Turner and J. A. Brown

In the course of developing electrochemical processing and analytical methods for indium, a study of the polarography of this element was carried out. The influence of the anion on the rate of cathode processes involving indium is readily demonstrated by polarography. The choice of anion for use in the electrolytic refining of the metal was made on the basis of these observations and its validity confirmed. The anomalous decrease in the rate of reduction of indium at increasingly negative dropping electrode potentials is explained on the same basis as the anion effect.

Abstract No. 94

AN ELECTRICAL PHENOMENON AT INTERFACES

Joseph G. Barredo

An equation of conductivity

$$I = zFK\xi^{\alpha}(4qdz/m)^{-1/4}N^{\alpha}t^{-1/2} + V/R$$

is deduced in which I = current; z,q = charge of the carrier and dipole, respectively; d = half of the length of the dipole; m = mass; t = time; ξ,N = number of dipoles and carriers, respectively; α = order of the reaction; K = constant; F = faraday.* It predicts a new electrical phenomenon at interfaces, and describes it as a function of the reaction and mobility of the carriers. The phenomenon was demonstrated experimentally for electrode-solution interfaces and for n- and p-type semiconductors.

Abstract No. 95

ELECTRODEPOSITION OF METALS
FROM ORGANIC SOLUTIONS
I. Introduction

Abner Brenner

The qualitative theoretical considerations involved in electrodeposition of metals from organic solutions are discussed, and the principle types of solutes and solvents are described.

Abstract No. 96

ELECTRODEPOSITION OF METALS
FROM ORGANIC SOLUTIONS
II. Further Studies on the Electrodeposition of Aluminum from the Hydride-Type Bath

Jean Connor

The stability and operating life of the hydride aluminum plating bath has been improved and addition agents have been found which permit thick deposits for electroforming to be produced. Adhesion of aluminum to other metals has been studied. A model, continuous-strip aluminum plating unit is described.

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* Preliminary work, J. G. Barredo, Phys. Rev., 83, 243(a)(1951); J. Chem. Phys., 19, 1065 (1951).

Abstract No. 97

ELECTRODEPOSITION OF METALS FROM ORGANIC SOLUTIONS III. Electrodeposition of Titanium- and Zirconium-Aluminum Alloys

Walter E. Reid, Jr.

Electrodeposition of titanium was investigated in various types of organic solutions, principally in ether solutions. The solutes investigated were: (a) hydrides, (b) borohydrides, and (c) organometallic compounds. A mixed type of bath containing both hydrides and borohydrides in ethyl ether has yielded deposits of titanium-aluminum and zirconium-aluminum alloys. Titanium alloys contained about 6% titanium and zirconium alloys contained up to 45% zirconium. Both alloys contained a few per cent boron.

New methods for the preparation of titanium borohydride and zirconium borohydride are described.

Abstract No. 98

ELECTRODEPOSITION OF METALS FROM ORGANIC SOLUTIONS IV. Electrodeposition of Beryllium and Beryllium Alloys

Gwendolyn B. Wood

Electrodeposition of beryllium from nonaqueous media, both organic and fused salt, was studied. Beryllium compounds of major interest included the halides, hydrides, borohydrides, and organometallics. Their preparation, chemical properties, and electrochemical properties in nonaqueous media were investigated. Electrodeposits of beryllium (95% pure) and beryllium alloys such as Be-B(70%, 30%), Be-Al, Be-Mg, etc., were obtained from organic solutions.

Abstract No. 99

ELECTROLYTIC PRODUCTION OF COATINGS ON MOLYBDENUM FROM FUSED SALTS

W. Beck* and M. Ford

* Present address: Department of Metallurgy, Syracuse University, Syracuse, N. Y.

Pretreatment of metal surface, electrolytic conditions in production of coatings on Mo consisting of compounds of this metal with Al, Si, and B from baths containing oxidic compounds of these elements, and leaching of bath salts from the coated specimens were studied.

The microstructure and the effects of time of electrolysis, bath temperature, and cathodic current density on the growth of the coatings are discussed.

Abstract No. 100

ELECTRODEPOSITION OF BISMUTH

Kelso B. Morris, Dolores Z. Douglass,*
and Clarence B. Vaughn

Bismuth metal of high purity has been electrodeposited from molten mixtures of bismuth trioxide (10% and 25%) and the eutectic mixture of sodium and calcium chlorides. The rate of metal recovery (g/hr) is good. Energy consumption, based solely on electrolysis and not on furnace requirements, is approximately 1 kwhr/lb of bismuth.

ELECTROTHERMICS AND METALLURGY

Abstract No. 101

THE BRIGHT SPARK IN THE METALS INDUSTRY

James D. Nisbet

This paper includes an historical review of vacuum melting, followed by some speculation on the future of vacuum melting in the metals industry.

Abstract No. 102

ARC MELTING IN HIGH VACUUM

P. C. Rossin

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* Present address: Pharmacy, Freedmen's Hospital, Washington, D. C.

Consumable electrode arc melting in the cold mold furnace represents the only practical method of achieving reaction free melting on a commercial scale. This paper discusses energy configurations of the electrode (cathode) and the bath (anode) as a function of controlled variables. A brief discussion of arc phenomena is included, supported by a film demonstrating magnetic arc deflection and arc stability. A treatise of the melting process is presented with emphasis on dynamic deoxidation and purification.

Abstract No. 103

VACUUM MELTING OF HIGH-ALLOY MATERIALS

Howard R. Spendelow, Jr., I. S. Servi,
and Glenn A. Fritzlen

Vacuum melting operations have been carried out on several types of high-alloy materials, both on a laboratory- and semicommercial scale. In general, it is possible to obtain much better control of analysis, particularly with respect to the more reactive elements, in vacuum melting as compared with normal air melting. The finished product is also generally cleaner in the metallurgical sense. The effect of vacuum melting on the hot-working and mechanical properties of alloys is also discussed.

Abstract No. 104

IMPACT PROPERTIES OF VACUUM MELTED IRON-CHROMIUM ALLOYS

J. L. Ham and F. L. Carr

A series of eight binary chromium-iron alloys containing from 19 to 49% chromium and accurately known amounts of residual carbon, nitrogen, and oxygen were subjected to standard charpy notched bar impact tests at precisely controlled testing temperatures. The ductile to brittle transition temperatures range from -41° to +350°C and, within a given grain size range, vary consistently with room temperature hardness. The hardness (as quenched from 900°C) depends on oxygen, nitrogen, and carbon content. The impact energy level above the transition temperature ranges from 80 ft lb to above the 220 ft lb capacity of the testing machine and varies consistently with the parameter (% C + % O_2). The parameter (% C + % N_2) cannot

be used as a reliable index of impact properties without a knowledge of oxygen content.

Abstract No. 105

VACUUM AND PRESSURE MELTING OF IRON-BASE ALLOYS

E. R. Morgan and Donald N. Frey

A description of the preparation of a wide variety of iron-base alloys, on a 25-lb laboratory scale, by means of vacuum and pressure melting is given. The alloys prepared in many cases include reactive elements which are not conveniently utilized in air melting. Cast ingots after working are tested for fatigue, stress-rupture, and other physical properties. Considerable improvement is produced in certain properties, whereas changes in other properties are disappointing. Limitations and advantages are briefly discussed.

Abstract No. 106

VACUUM INDUCTION-MELTED ZIRCONIUM AND ZIRCONIUM ALLOYS

H. A. Saller, R. F. Dickerson,
and E. L. Foster, Jr.

Two types of zirconium and three zirconium alloys have been vacuum induction melted and their properties determined. Sponge zirconium, iodide zirconium machine chips, Zircaloy 2 (zirconium - 1.5 w/o tin - 0.12 w/o iron - 0.10 w/o chromium - 0.05 w/o nickel), and zirconium alloys containing 2.5 and 5.0 w/o tin, respectively, were the specific materials investigated. Vacuum-melting techniques were studied and data on hardness, electrical resistivity, corrosion behavior in 400°C steam and 315°, 260°, and 200°C water, and the capacity of the metal to be drawn (drawability) were accumulated.

Abstract No. 107

AN EVALUATION OF FINELY DIVIDED ZIRCONIUM POWDER

Winston Bachmann and Richard H. Gale

One of the fundamental raw materials needed to

produce quality photoflash lamps is zirconium metal powder. An evaluation of the physical and chemical properties of this material as they effect its combustion properties has been made.

Minimum limits for chemical purity have been found below which combustion is not immediately complete. Contributions due to particle size and to particle size distribution have been evaluated in relation to the combustion properties of zirconium powder.

Abstract No. 108

DESIGN AND OPERATION OF AN INDUCTION AND A RESISTANCE FURNACE FOR HIGH VACUUM-HIGH TEMPERATURE APPLICATIONS

R. F. Domagala and D. J. McPherson

High vacuum furnaces to operate at temperatures up to 2000°-2500°C and pressures of less than one micron are requisite to prevent contamination of highly reactive materials during many thermal experiments. The design and construction of two such furnaces will be discussed.

One furnace, an induction unit employing a tantalum susceptor and zirconia insulation, is powered by a high-frequency oscillator. The second furnace is a resistance type furnace with molybdenum heater and radiation shields, current being supplied and controlled by a pair of transformers. The high vacuum is attained in these furnaces by using a DPI Model MC-275 diffusion pump backed up by a VSM-556 Kinney vacuum pump, contained on a portable unit.

Abstract No. 109

A NEW METHOD FOR THE EVALUATION OF HIGH VACUUM FURNACES AND HEAT-TREATING ATMOSPHERES

W. R. McMillan and Earl A. Gulbransen

A special vacuum furnace is used to study the reactions of a number of metals and alloys in high vacuum of 10^{-7}mm Hg, in oxygen atmospheres of 5×10^{-6} to 1×10^{-6}mm Hg and in specially purified hydrogen atmospheres. Results show that the brightness of metal sample is not necessarily a criteria for the lack of reaction. A thin oxide film forms on pure metals in a vacuum of 10^{-7}mm Hg

together with a number of oxide crystals 0.1-2 microns in size. The number of oxide crystallites is a function of the oxygen pressure and time of reaction. For metals containing carbon, reaction with the surface oxide occurs which limits attack by oxygen. The extent of discontinuous oxidation for pure metals may be used to evaluate the heat-treating system and atmosphere.

Abstract No. 110

THEORY AND PERFORMANCE CHARACTERISTICS OF A KINNEY MECHANICAL BOOSTER VACUUM PUMP

C. M. Van Atta and R. L. Sylvester

A high-speed, positive displacement mechanical pump has been developed as the high-vacuum stage of a two-stage mechanical vacuum pump combination. The new mechanical booster vacuum pump is not dependent upon a sealing fluid but attains high pumping efficiency by the maintenance of mechanical clearances small as compared with the molecular mean-free-path at reduced pressure. In addition to high pumping efficiency, a compression ratio of the order of 60/1 is maintained against the fore-pressure provided by a standard single stage pump, resulting in high pumping speed and very low effective vapor pressure, and giving a blank off of 10^{-4}mm Hg (McLeod).

The theory of operation of the mechanical booster vacuum pump will be presented together with measured performance curves.

Abstract No. 111

ROTARY GAS BALLAST PUMPS

William Frye

The principals of operation of the gas ballast pump are reviewed. Application of the pumps in specific processes such as vacuum melting and vacuum deposition is noted, and the advantages and limitations of the gas ballast pump in these operations are discussed.

Abstract No. 112

ECONOMICS OF VACUUM MELTING

G. J. Crites

Basically, every process can be reduced to a matter of dollars and cents by the study of the inherent cost of that process. Vacuum melting is no different in this respect. Stripped of high novelty, demand, research, and amortization cost, it suddenly becomes apparent that the basic costs of vacuum melting differ little from those of similarly sized atmospheric induction melting furnaces. There is a finite increase in melting cost but when one considers the over-all cost of specialty materials, it is insignificant.

It is apparent that within the next few years the vastly improved properties resulting from vacuum melting will mean that most specialty materials will be produced in vacuum furnaces.

Abstract No. 113

DEOXIDATION OF VACUUM MELTED M 252

W. F. Moore and R. K. McKechnie

The reactivity of titanium with oxygen and nitrogen in the atmosphere makes conventional air melting of high temperature alloy M 252 a borderline case and, therefore, a case for vacuum melting.

In the vacuum melting and casting process for production of this alloy, deoxidation experiments have been conducted utilizing two methods of deoxidation and a number of different deoxidizing agents. The nominal composition for this alloy vacuum melted is:

Ni	Bal.	Fe	5 max.
Cr	18/20	Ti	2.25/2.75
Co	9/11	Al	0.5/1.5
Mo	9/11	C	0.10/0.20

Results have been evaluated on the basis of vacuum fusion gas analysis and forgeability as determined by an upset test.

From the limited number of tests run, no correlation could be found between oxygen and nitrogen content and forgeability. The residual deoxidizing material in the alloy apparently has a more potent effect on forgeability than oxygen up to 0.02% and nitrogen up to 0.002%.

Abstract No. 114

HYDROGEN DEOXIDATION OF VACUUM-MELTED HIGH-TEMPERATURE ALLOYS

R. L. Hadley and L. M. Bianchi

A furnace for experimental vacuum melting and deoxidation of alloys is described. The furnace is equipped for charging, melting, and casting without exposure to air. A platinum to platinum-rhodium thermocouple is used for temperature measurements and the entire melting process is operated by a program control. Apparatus for periodic sampling of melt and atmosphere is included for use in process investigation.

The hydrogen deoxidation of liquid iron, nickel, cobalt, and their alloys with chromium in vacuum melting equipment is described. The effect of process variables on deoxidation under conditions applicable to commercial vacuum melting are noted.

Abstract No. 115

APPLICATION OF VACUUM TECHNOLOGY TO METALLURGICAL PROCESSES

Robert G. Ulrech

This paper will incorporate a discussion of the various metallurgical processes to which vacuum technology is now being applied on a commercial scale. It will also include a discussion of the various problems encountered by the vacuum engineer in designing equipment to meet the requirements imposed by these new applications.

Abstract No. 116

VACUUM HEAT-TREATING TECHNIQUES

Richard L. Hoff and A. M. Bounds

Vacuum heat-treating techniques used on a variety of commercial alloys as well as on several reactive metals are described. Alloys such as beryllium copper, "K" Monel, or any alloy containing elements which combine with gases unavoidably present in prepared atmospheres may be successfully heat treated in vacuum. Production vacuum equipment provides excellent protection during heat treating for a variety of materials, in some

instances affecting surface films for removing certain impurities and thereby improving mechanical properties. Vacuum techniques are properly and economically applicable to a variety of metals. As experience is gained with production equipment, new applications will lend themselves to vacuum techniques.

Abstract No. 117

SOLID STATE PURIFICATION OF MOLYBDENUM BY INDUCTION HEATING

J. E. Drennan, W. W. Kleinschmidt, and F. C. Todd

In the development of voltage regulator tubes, it was found that heating molybdenum electrodes to high temperatures at pressures of 10^{-4}mm Hg or less for extended times was not only effective in reducing drastically the gas content but resulted in a great increase in ductility. This is in contrast to the embrittlement resulting from short-period heat treating. Heat treatment of intermediate duration results in anisotropy in ductility with respect to the direction of rolling.

The equipment for the vacuum treatment will be described and microphotographs of the grain structure of the molybdenum before and after heat treatment will be shown. Comparative characteristics of the voltage regulator tubes will also be presented.

Abstract No. 118

VACUUM DEGASSING OF TITANIUM

C. B. Griffith and M. W. Mallett

Physical properties of titanium, particularly impact strength and ductility, are deleteriously affected by hydrogen. Hydrogen contents can be lowered by vacuum annealing. To determine optimum conditions for degassing, the hydrogen solubilities in two types of commercial titanium were determined at temperatures of 700° to 850°C and at hydrogen pressures of 0.05-4 microns Hg. Data follow the square-root law of pressure dependency.

Data also were obtained on the effects of temperature and specimen dimensions on the degassing rate.

Titanium degassed according to specifications based on these data shows improved physical properties.

Abstract No. 119

VAPOR PRESSURES OF METALS AND ALLOYS

Rudolph Speiser and J. W. Spretnak

The Knudsen (effusion through an orifice into a high vacuum) and the Langmuir (sublimation or evaporation from a surface into a high vacuum) methods of determining vapor pressures of metals and partial pressures of a component of an alloy are described and discussed. Either the loss in weight of a sample or the mass of vapor condensed on a suitable target, in unit time, can be used to determine rates of effusion or sublimation. From these data, vapor pressures can be computed. Several methods for determining the composition of the condensate are available so that partial pressures over multicomponent alloys can be computed.

Vapor pressures of the pure metals can be utilized to calculate heats of sublimation and, in some cases, heats of transition. Partial pressures of the components of an alloy can be used to calculate activities and other thermodynamic quantities. Application of these procedures to several binary and ternary alloys will be discussed.

Abstract No. 120

VAPOR PRESSURE MEASUREMENTS IN THE Ca-Al SYSTEM

H. Hancock and L. M. Pidgeon

The vapor pressure of Ca over Ca-Al alloys was measured in the temperature range 1100°-1200°C. A gas-tight system consisting of two temperature zones contained the Ca-Al alloy at the higher temperature and calcium metal at the lower temperature. When equilibrium was established the system was cooled rapidly and the composition of the Ca-Al alloy determined. Equilibrium vapor pressure was obtained from published valves of the vapor pressure of calcium metal. Substantial derivatives from Raoult's law were observed.

Abstract No. 121

REMOVAL OF VOLATILE CONSTITUENTS FROM NONFERROUS ALLOYS BY VACUUM DISTILLATION

M. J. Spendlove

During the past few years, the Bureau of Mines has made a series of studies on the separation of nonferrous metals by vacuum distillation. It was found that zinc can be employed to leach aluminum selectively from a number of other metals and then evaporated to completion to obtain refined aluminum. Studies were also made on the removal of volatile metals from lead and tin by vacuum distillation. Other metals studied in these investigations include cadmium, magnesium, arsenic, antimony, bismuth, tellurium, and zinc. The advantages derived in an application of this metallurgical technique are by no means confined to the metals considered. Past results have been encouraging and the Bureau of Mines plans to extend investigations into the fields of fractional distillation and controlled low-pressure gas reactions.

SPRING MEETING

at the

SHERATON-GIBSON HOTEL

Cincinnati, Ohio

May 1, 2, 3, 4, and 5, 1955

Sessions probably will be scheduled on

Electric Insulation

Electronics

Electro-Organic Chemistry

Industrial Electrolytics

Theoretical Electrochemistry

Abstracts for the Spring Meeting (not exceeding 75 words in length) must reach the Secretary's Office, 216 West 102nd Street, New York 25, N. Y. not later than January 15, 1955 in order to be included in the program

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